Dun Echt Observatory Publications.

VOL. III.

MAURITIUS EXPEDITION, 1874.

DIVISION II.

DETERMINATIONS OF LONGITUDE AND LATITUDE.

WITH TWO PLATES.

ROYAL SOCIETY EDINBURGH

DUN ECHT, ABERDEEN.

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Additional Errata in Dun Echt Observatory Publications, Vol. III.

Page 356, 4th line above table; and page 416, 3rd line above table, *dele* "and local sidereal".

The corrections indicated in the note on page xii, are:—

Page 494, line 21, *for* $52^s{\cdot}43$ *read* $52^s{\cdot}53$.
„ „ line 23, *for* $48^s{\cdot}910$ *read* $49^s{\cdot}01$.
„ „ last paragraph, *add* $0^s{\cdot}12$ throughout, so that the last line *reads* $46^s{\cdot}51$ *for* $46^s{\cdot}390$.
„ 495, line 17, increase the quantities by $+0^s{\cdot}14$.
Page 495, line 21, *for* $40^s{\cdot}53$ *read* $40^s{\cdot}60$.
„ 496, line 5, from bottom, *for* $57^s{\cdot}67$ *read* $57^s{\cdot}74$.
„ 497, line 9, *for* $11^s{\cdot}73$ *read* $11^s{\cdot}80$.
„ „ line 7, from bottom, *for* $39^s{\cdot}64$ *read* $39^s{\cdot}71$.
„ 498, last line of text, *for* $42^s{\cdot}37$ *read* $42^s{\cdot}44$.

Dun Echt Observatory Publications.

VOL. III.

PREFACE.

After a lapse of time, which by some may be deemed excessive, I am now enabled to present a further instalment of the account of my Expedition to Mauritius for the Observation of the Transit of Venus, in the year 1874. It is unnecessary for me to recapitulate the history already given in the preface to Vol. II. of these publications, and I would therefore merely remind the reader of its existence.

The present volume, forming the second part of the account, contains full particulars of the determinations of longitude and latitude connected with the Expedition.

Continuing the utilisation of the materials collected, and of which the determination of the Solar Parallax by observations of Juno was the first result, Dr. Gill undertook the reduction of the greater part of the observations recorded in the present volume. Owing, however, to various other occupations—notably the Expedition to Ascension in 1877 for the Observation of the Opposition of Mars—Dr. Gill relinquished the work in the month of March 1879, returning all the observations and computations to Dun Echt.

Although much valuable work had been accomplished, it was considered desirable in almost all cases to undertake fresh reductions based on the original observations. The Introduction and Chapter I. are, however, mainly in the form in which they left Dr. Gill's pen.

In the month of November 1881 the work was so far advanced that I considered myself justified in going to press, and the printing was continued as far as page 392 by the commencement of the year 1883.

The absence of Dr. Copeland, as head of H.M. Transit of Venus Expedition to Jamaica, and his subsequent journey on my behalf to the lofty tablelands of Peru and Bolivia, added to the severe illness of Mr. J. G. Lohse, who remained in charge at Dun Echt, caused us completely to suspend all printing operations, and they were not fairly recommenced until the beginning of the present year.

Given a large mass of observations, some few of which must necessarily be liable to exclusion from a share in the result, it becomes possible so to discuss them as slightly to modify the final deductions.

In the following pages many cases will appear in which it would have been possible to have retained this or that quantity which has been discarded, and *vice versâ*.

To show therefore the exact course followed in the reductions, the original observations have been printed in all practicable fulness. Then by giving each subsequent step in the reductions, it is in the power of the reader not only to check any particular result as derived from the figures as they stand, but also to detect any misprints that may have crept into either results or observations.

A somewhat strict adherence to this plan in the case of the telegraphic signals has caused the volume to be considerably larger than it need otherwise have been; but the result is as I wished, and I think so far satisfactory, that any class of signals, or indeed any individual signal, can be directly traced to its original record, or to its effect on the final result.

The operations for determination of the differences of personal equation between the observers have been given no less fully than the rest of the work, whenever the materials were accessible. This is the more necessary from the very considerable amount of these corrections compared with the probable errors in finding and transmitting the time.

A few words respecting the more obvious precautions to be observed in any future longitude operations may not be here altogether out of place.

Probably the elimination of personal equation can be most satisfactorily effected by a complete interchange of observers and instruments. This would of itself enforce the use of

portable instruments. That these should preferably be of similar design is a precaution so obvious that it would not have deserved mention, had not the gradual extension of our operations led to the use of instruments of the most dissimilar character.

The choice of observing sites is one of very great difficulty; but, without going into unnecessary detail, it seems certain that nothing short of a practically isolated foundation on firm ground ought to satisfy the observer. Proximity to the telegraph station and facilities of reference to permanent marks would naturally not be left out of consideration.

Next to the pleasure of being able to recall the memories of assistance and kindnesses freely showered upon myself and my companions, I venture to rank that of publicly recording my thanks to those at whose hands they were received.

In Volume II. I mentioned the names of Messrs. Connal, Parsons, Watt, and Meldrum, together with that of M. Ed. de Chazal, my kind host while resident in Mauritius, and who to my unfeigned grief has since paid the debt of nature, dying, as he lived, surrounded by his children and his children's children.

I have now to express my warmest thanks to Professor Auwers, Professor Van de Sande Bakhuyzen, and the members of the German and Dutch Expeditions, to Sir George Airy, who for so many years was the chief of our national observatory, to Captain Wharton (now Hydrographer to the Admiralty), and the officers of H.M.S. 'Shearwater,' as well as to the members of the British Transit of Venus Expedition to Rodriguez.

To Dr. Löw and Dr. Pechüle I owe a special debt for their great kindness in assisting in the homeward longitude work, and without whom many of the operations would have had to be abandoned.

I point with pride to the liberal and enlightened action of the Eastern Telegraph Company in permitting night after night the free use of their cables, and to the uniform courtesy and intelligence evinced by their officials.

And may I here add a word of thanks to the members of my own staff—to Dr. Gill for his indomitable zeal in making so many of the observations; to Mr. H. J. Carpenter for his great

care and diligence, not only during the progress of the reductions, but also in reading the proofs of this volume after his departure from Dun Echt; to Mr. J. G. Lohse for his able and constant attention to all points of detail; and finally to Dr. Copeland, under whose supervision the whole of the work of producing this volume has been carried out in a manner which I trust may reflect some credit on an establishment which, though it bears the designation of 'amateur,' still has at heart the desire of carrying out its labours in a manner worthy of a public institution.

CRAWFORD.

DUN ECHT: *June* 10, 1885.

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Errata in Dun Echt Observatory Publications, Vol. I.

Preface	Line 10, *read* Robert Copeland		
No. 80	Colour of B = blue	β *	
87	Mag. of A = 8·0	β	
9[1]	(on p. 20) *for* χ^1 χ^2 *read* κ^1 κ^2	Rev. T. W. Webb	
112	Decl. = 45° 41′	β	
300	Decl. = 28° 55′	β	
376	Position = 251° 22′	β	
444	Name = 15*n* Pleiad.	β	
544	Epoch = 1831·72	β	
548	Distance = 14″·197	β	
563	Decl. = 40° 50′	β	
733	Decl. = 15° 52′	β	
943	Position = 165°·90	β	
983	Colour of A = yellow	β	
990	Decl. = −14° 6′	β	
1012	Decl. = 28° 20′	β	
1058	Decl. = 9° 47′	β and Pos. med.	
1062	R.A. = 7^h 12^m·7	β	
,,	Decl. = 55° 30′	β	
,,	Epoch = 1829·51	β	
,,	Distance = 14″·724	β	
No. 1062	Position = 313°·84	β	
,,	Mags. A = 5·3, B = 6·6	β	
,,	Colours = grnsh. wh. & blsh. wh.	β	
1066	Epoch = 1829·72	β	
1153	Decl. = 12° 20′	β	
1245	Mag. of A = 6·0	β	
1292	Decl. = −0° 6′	β	
1516	In *note*, Epoch = 1823·27	Positiones med.	
1525	Decl. = 48° 9′	β	
1714	Decl. = +24° 19′	β	
1727	Position = 334°·97	β	
1806	Decl. = 49° 7′	β	
1928	Position = 277°·65	β	
1949	Decl. = 13° 27′	β	
2008	Decl. = −2° 18′	β	
32[1]	On p. 79, Decl. = 47° 32′	β	
3110	On p. 80, Decl. = −2° 25′	β	
2589	Distance = 5″·008	β	
2601	Position = 166°·05	β	
60[1]	On p. 115, Pos. = 210° 36′·8	β	

* The errata marked '*β*' were pointed out by Mr. Burnham.

Additions and Corrections to Dun Echt Observatory Publications, Vol. I., drawn from the 'Stellarum fixarum imprimis duplicium . . . positiones mediæ' †—F. G. W. Struve, 1852.

λ Arietis	(On p. 8) = H. V. 12	1833	A relative change of magnitude suspected
240	Is *not* Arietis 65 B	1966	A relative change of magnitude suspected
o (Mira) Ceti	(On p. 10) = H. VI. 1	1993	A relative change of magnitude suspected
269	= Piazzi II. 89	β Scorpionis	(On p. 75) = H. III. 7
41 Arietis	(On p. 12) = H. V. 116; = H. VI. 5	43 Herculis	(On p. 78) = H. VI. 116
410	The measures belong to a neighbouring star	2118	= 19 Draconis
518	= H. II. 80; = H. VI.	2205	= 2215
533	= H. IV. 72	2215	= 2215*a*
571	= H. III. 95	2247	The measures belong to a neighbouring star
10 Camelop.	(On p. 23) = H. VI. 36	67 Ophiuchi	(On p. 85) = H. VI. 2
56 Aurigæ	(On p. 36) = H. V. 107	2426	Angle of position = 259°·77
1198	A relative change of magnitude suspected	2622	Is not Piazzi, xix. 392
1237	The measures belong to a neighbouring star	2647	Angle of position = 263°·15
6^{II} Regulus	(On p. 52) = H. VI. 11	2669	To be struck out. See *Positiones mediæ*, pp. cviii. and 136
1568	A relative change of magnitude suspected		
δ Corvi	(On p. 61) = H. IV. 105	11ρ Capric.	(On p. 102) = H. II. 51
1686	A relative change of magnitude suspected	120 Capric.	(On p. 102) = H. IV. 71
54 Virginis	(On p. 64) = H. II. 45	29 Aquarii	(On p. 109) = H. I.
1768	= 25 Canum Venat.	53 Aquarii	(On p. 111) = H. III.

† This work was not consulted when the 'Summary' in Volume I. was drawn up. Corrections in the places of the stars of less than 3′ have been omitted.

Amended places for 1875·0

Number	R.A.	Decl.	Number	R.A.	Decl.	Number	R.A.	Decl.
	h. m.	° ′		h. m.	° ′		h. m.	° ′
3	0 3·5	45 42	1305	9 0·3	80 19	2099	16 39·5	70 33
18	0 14·1	66 58	1350	9 23·9	67 21	2124	16 58·8	65 24
95	1 4·1	− 5 38	1360	9 23·9	11 9	2171	17 22·4	− 9 54
102	1 10·5	48 21	1378	9 39·2	75 0	2198	17 37·7	26 36
156	1 38·5	59 45	1407	9 59·8	65 3	2207	17 37·2	67 11
230	2 6·2	57 54	1410	10 13·1	86 42	2215	17 40·2	17 46
264	2 20·4	60 5	1428	10 18·1	53 16	2218	17 39·5	63 44
281	2 29·3	5 3	1472	10 40·4	13 38	2261	17 55·3	52 14
312	2 43·7	72 23	1479	10 49·2	83 54	2273	17 58·5	64 9
345	3 0·6	78 2	1499	10 57·2	83 47	2343	18 29·3	65 1
362	3 6·3	59 34	1517	11 7·1	20 48	2470	19 4·2	34 34
418	3 31·4	74 58	1526	11 12·2	3 30	2577	19 39·7	20 36
468	3 47·0	− 2 11	1558	11 30·1	22 10	2588	19 45·0	44 4
494	4 1·5	22 46	1583	11 53·1	87 41	2602	19 49·2	−13 41
557	4 26·1	62 43	1588	11 55·8	73 4	2611	19 55·1	47 1
635	4 57·7	54 49	1625	12 10·7	80 49	2614	19 26·0	88 7
784	5 47·0	84 12	1705	12 54·6	15 3	2627	20 1·5	4 24
862	6 4·1	29 31	1758	13 27·7	49 47	2654	20 8·7	− 3 53
866	6 6·6	62 14	1782	13 39·1	18 59	2784	21 11·1	73 32
871	6 5·2	− 0 44	1801	14 0·5	6 34	2858	21 50·9	86 18
939	6 29·3	5 25	1814	14 6·5	50 50	2881	22 8·9	28 57
958	6 37·8	55 51	1840	14 17·5	68 22	2942	22 38·4	38 49
980	6 49·8	72 51	1860	14 30·0	55 47	2967	22 52·9	27 4
1028	7 2·3	−10 26	1966	15 35·2	−10 44	2971	22 54·1	77 49
1183	8 0·5	− 8 53	2034	16 4·3	83 59	2986	23 3·8	13 45
1192	8 5·4	60 43	2036	16 10·6	72 53	3040	23 41·8	9 27
1262	8 34·7	24 15	2046	16 19·8	64 40	3051	23 56·4	79 35

Errata in Dun Echt Observatory Publications, Vol. II.

On the title-page, *for* ④ *read* ③; this error occurs also on page 1.
Page 70, line 7 from bottom, *read* $\cos q = \tan(\pi - N)\cot\zeta$.
On pp. 71 and 72, Mauritius being in south latitude, the tabular quantities N are really the supplements of N.

Page 73. Argument $0^h\ 59^m$, $N = 31°\ 58'\ 18''$.
On pages 73 and 74, N is *negative* from 6^h to 18^h.

Errata in this Volume (III.)

Page 6, line 20 from top, *for* Rodriguez *read* Réunion.
,, 16, lines 34 and 35, *strike out* After the return of this chronometer from Mauritius, and after it had been tested a second time at Liverpool, *and insert* Subsequently, at our request, &c.—[N.B. The chronometer was not taken to Mauritius.]
,, 17, first table, first column, *for* 1872 April 5 *read* 1871 April 5.
,, 84, the 2nd star on Sept. 15, *f* has fallen out.
,, 96, Sept. 11, *for* ε Aquilæ *read* ζ Aquilæ.
,, 100, Sept. 22, 8th star, β has fallen out.
,, 103, Sept. 14, *for* +1·21 in 'Sum of Instrumental Corrections' *read* 1·23.
,, 103, Sept. 14, γ Aquilæ, 'R.A. of Star,' *for* $7^s{\cdot}58$ *read* $18^s{\cdot}37$.
,, ,, ,, α ,, *for* $29^s{\cdot}40$ *read* $40^s{\cdot}41$.
,, ,, ,, β ,, *for* $48^m\ 58^s{\cdot}73$ *read* $49^m\ 9^s{\cdot}76$.
,, 105, Sept. 22, 12 Ceti, 'R.A. of Star,' *for* $39^s{\cdot}41$ *read* $39^s{\cdot}43$.
,, 115, Dec. 21, α Tauri, 'R.A. of Star,' *for* $45^s{\cdot}65$ *read* $45^s{\cdot}68$.
,, 138, Jan. 2, γ Canis maj., 'R.A. of Star,' *for* 5^h *read* 6^h.
,, 179, last line but one, *for* Houdoul's Jetty *read* Hodoul Jetty.
,, 182, heading of letter, *for* Coluba *read* Colába.
,, 198, line 5, *for* +12° 47′ 22″·1 (Chap. XX.) *read* +12° 47′ 17″·3 (p. 460).

Page 198, last Z.D. of α Can. min., *for* 58″.67 *read* 56″.87.
,, 230, Feb. 5, 4th star, τ has fallen out.
,, 232, line 3 from bottom, γ has fallen out.
,, 243, last line, *for* κ *read* χ.
,, 293, Mar. 10, 33 Leonis min., 'R.A. of Star,' *for* 27^m *read* 24^m.
,, 346, middle of page, 'Personal equation . . . in sending signals,' *for* $+0^s{\cdot}08$ *read* $+0^s{\cdot}02$.
,, 346, in the final result, 'Alexandria east of Berlin,' *for* $58^s{\cdot}81$ *read* $58^s{\cdot}75$.
,, 348, line 11, *for* $0^h\ 4^m\ 28^s{\cdot}245$ *read* $0^h\ 4^m\ 28^s{\cdot}274$; and line 13, *for* $1^h\ 5^m\ 58^s{\cdot}91$ *read* $1^h\ 5^m\ 58^s{\cdot}942$.
,, 350, Mar. 10, last star, *for* χ *read* κ.
,, 352 and 355, Mar. 15, *for* ε Boötis *read e* Boötis.
,, 392, line 8, *for* $0^h\ 4^m\ 28^s{\cdot}556$ *read* $0^h\ 4^m\ 28^s{\cdot}464$.
,, ,, lines 12 and 13, *for* $0^h\ 4^m\ 28^s{\cdot}355 - 0^s{\cdot}110$ *read* $0^h\ 4^m\ 28^s{\cdot}385 - 0^s{\cdot}111$.
,, 392, line 15, *for* $0^h\ 4^m\ 28^s{\cdot}245$* *read* $0^h\ 4^m\ 28^s{\cdot}274$*.
,, 460, line 12 from bottom, *for* Circus of the Steamboat Pier *read* Prince of Wales's Crescent.

NOTE to p. 198.—The change of −4″·8 in the adopted latitude alters the chronometer correction on January 20 by $-0^s{\cdot}08$, besides affecting the Aden values of R. This leads to an increase of the eastern longitudes of the Mauritian stations and Rodriguez by $+0^s{\cdot}07$, of Seychelles by $+0^s{\cdot}10$, and of Réunion by $+0^s{\cdot}12$. These corrections have still to be applied to the values in Chapter XXIII.

THE TRANSIT OF VENUS EXPEDITION.

PART II.

DETERMINATIONS OF LONGITUDE AND LATITUDE.

INTRODUCTION TO THE LONGITUDES.

IN order that the reader may more easily follow the various operations detailed in this volume it may be well to begin with a general summary of the whole.

The problem was to determine the longitude of the station at Mauritius where the transit of Venus was to be observed. We very much desired to secure as accurate a result as possible, because the station was likely to become a central one, i.e. to be connected with many other transit of Venus stations.[1] Under these circumstances it was not thought desirable to rely solely upon observations of the moon; and, indeed, the experience of the Americans in determining the longitude of Washington (see Dr. Gould's 'Transatlantic Longitude') seemed to point to the impossibility of determining any longitude by means of observations of the moon without a possible error of two or three seconds of time. Accordingly, Lord Lindsay determined that an attempt should be made to connect Aden with Greenwich by telegraph, and Mauritius with Aden by chronometers.

For the first part of the operation, we knew that the British Government party intended to connect Greenwich and Suez by telegraph. It was also understood that Mr. Hunter (of the British Government party) would remain at Suez to exchange signals with Mr. Gill on his return to Aden after the transit, and that thus the longitude of Aden would be determined.

However, a very short time before Mr. Gill left England for Mauritius it was found that, as the arrangement of the mail steamers would not permit Mr. Gill to leave Mauritius before January 8, 1875, the British obsērvers and their instruments could not be detained in Egypt so long as the end of January, and that therefore some other plan of determining the longitude of Aden must be devised. We at once put ourselves in communication with Professor A. Auwers, of Berlin (secretary to the German Transit of Venus Commission), and with Professor H. G. van de Sande Bakhuyzen, of Leyden, on behalf of the Dutch Government. A reply was

[1] The result has proved that the latter expectation was fully justified, for Belmont has actually been connected with five stations where the transit of Venus was observed, viz. :—

Rodriguez, the British Government station.

Pamplemousses (Mauritius), Dr. Meldrum's station.

Solitude (Mauritius), a German Transit of Venus Commission station.

Réunion, the Dutch Transit of Venus station.

St. Paul, a French Transit of Venus station.

received from Professor Auwers by return of post, to say that the German astronomers, who would leave for Mauritius by the mail following Mr. Gill, would have instructions to co-operate with Lord Lindsay's expedition in every possible way, and that one of the German astronomers would assist in the telegraphic connection of Suez with Aden on the return voyage. Professor Bakhuyzen also wrote to the effect that if the German astronomers could not co-operate in the telegraphic longitudes, one of the Dutch astronomers would certainly do so; and thus, so far, the matter was satisfactorily arranged.

Some months before this chronometers had been hired from the chief makers who had instruments at disposal, and these, to the number of fifty, were sent to the Liverpool Observatory, there to be tested by Mr. Hartnup, in order to determine their temperature coefficients.

On June 14, 1874, Mr. Gill went to Liverpool Observatory, made observations for time, compared the chronometers, and the following day conveyed them by railway to the Royal Observatory, Greenwich. The chronometers remained there until June 18, when they were conveyed by railway to Southampton, and duly mounted in their gimbals in a cabin of the Peninsular and Oriental Steam Navigation Company's steamer 'Mirzapore,' then lying in Southampton Docks.

On June 19 the 'Mirzapore' sailed from Southampton, and reached Malta on June 27. Mr. Gill addressed a letter from the telegraph office, Malta, to Professor Auwers at Berlin, pointing out the possibility of making an independent determination of the longitude of Suez viâ Malta, provided that the consent of the Eastern Telegraph authorities could be secured; and this, the officials at Malta assured Mr. Gill, there would probably be no difficulty in obtaining.

On July 1 the 'Mirzapore' reached Alexandria, and Mr. Gill at once visited Mr. Gibbs, chief of the Eastern Telegraph Company's Mediterranean stations. That gentleman entered with the utmost energy and goodwill into the whole matter, so that a second letter was sent to Prof. Auwers, confirming the possibility of making an independent determination of the longitude of Suez viâ Alexandria, Malta, and Berlin. The following evening the 'Mirzapore' sailed for Suez, where she arrived on July 5. An observing station was selected in an enclosure belonging to the Messageries Impériales.[2]

On July 6 the altazimuth and some chronometers were duly conveyed to this station, and on the 6th, 7th, and 8th observations for time were made; on the 7th and 8th observations were also made for latitude. After the time determination chronometers were transported by boat between the observing station and the ship.

On July 9 the 'Mirzapore' sailed from Suez, and reached Aden on July 15.

The chronometers were at once landed, and conveyed to the police station for safety. On the following day they were removed on board the 'Godavery,' a steamer of the Messageries Impériales about to sail for Mauritius, and mounted in their gimbals in one of the cabins. Cloudy weather prevented observations until July 18, when satisfactory time determinations were secured.

[2] This enclosure belonged formerly to the workshops of the company, and the buildings are still to some extent used as storehouses. Since the opening of the Suez Canal the tools have been removed to Marseilles.

The observing site was nearly opposite the Austrian Consulate, which opens into this enclosure, and the consul kindly undertook to have a brick foundation built to mark the spot, and to form the foundation of the pillar of the transit instrument which would be employed in the telegraphic operations for longitude on the return journey.

On July 19 the night was again cloudy, and on July 20 the 'Godavery' sailed for Mauritius. On August 3 the 'Godavery' reached Réunion, and dropped anchor the following day in the harbour of Port Louis, Mauritius. The same night the altazimuth was set up at Fort George, and an attempt was made to secure observations there, but without success. The night of August 5 was hopelessly cloudy; and on August 6 another attempt was made to determine time at Fort George, but with only partial success.

Seeing that the chances of observation were so precarious at Fort George, and the fatigue of going to and from Pamplemousses extreme, Mr. Gill had one box of the chronometers transported to Pamplemousses by hand, and on the night of August 7 secured observations with the transit instrument of the observatory there. Soon after Mr. Gill's arrival at Mauritius he met Lieutenant Neate, R.N., with the rest of a British Transit of Venus party, whose instructions were, if possible, to connect Rodriguez (their station), by means of chronometers, with Lord Lindsay's station. Application was made by Lieutenant Neate for the loan of Lord Lindsay's chronometers for this purpose, and it was arranged that, as soon as the clocks and transit instrument had been fairly established at Rodriguez, H.M.S. 'Shearwater' should return for the purpose of conveying Lord Lindsay's chronometers to Rodriguez and back. This arrangement was duly carried out, and forty-two of Lord Lindsay's chronometers were put on board the 'Shearwater' on September 8. Two double runs connecting Pamplemousses with Rodriguez were made, the details of which will be found in the account of the 'Rodriguez-Pamplemousses Longitude.' The operations connected with this run extended from September 8 till September 24.

Meanwhile the work of preparing the station at Belmont—levelling the rock, removing loose stones, and making paths between the observatories—had been in progress. Mr. Gill had also made a series of observations for determining the latitude of Pamplemousses. Before the completion of the Rodriguez-Pamplemousses longitude work, the transit hut and photographic room, which had been sent out by the September mail, were erected. After the transit of Venus had been observed, the operations in connection with the longitudes were resumed.

The first steps taken were for the determination of the difference of longitude between Belmont and Solitude (the German station). For this purpose a field telegraph (lent by H.M. War Office) was laid down between Belmont and Poudre d'Or (the nearest railway station), and between Solitude and its nearest station (Union Vale). By this means telegraphic signals were exchanged with Solitude between Dr. Copeland at Belmont and Drs. Löw and Pechüle at Solitude, and, as an additional check, thirty-six chronometers were also transported from Belmont to Solitude and back. The details of this operation will be found under the head of 'Belmont-Solitude Longitude.'

To complete the local longitudes in Mauritius, it still remained to connect Belmont with Pamplemousses. For this purpose the field telegraph which had been laid down between Belmont and Poudre d'Or railway station was utilised, and advantage taken of the railway telegraph wires connecting Poudre d'Or with Pamplemousses railway station, whence Dr. Meldrum's special wire completed the connection between the two observatories. On the evening of January 2, Mr. Gill left Belmont with two light spring carts (carioles), one carrying eight chronometers, the other the altazimuth. On arrival at Pamplemousses, the alt-

azimuth was set up, and observations for time were made the same night and on the night following.

At a prearranged hour the same evening seven rockets were discharged at an intermediate station, five of which were simultaneously observed at Belmont and Pamplemousses. Telegraphic signals were exchanged on January 2 and 3, and on January 4 Mr. Gill returned to Belmont, taking the chronometers with him, so that the transport of chronometers gave a third check on the longitude. The time determinations at Belmont were made by Dr. Pechüle, both Lord Lindsay and Dr. Copeland being prostrated at the time by fever. The details of the operations will be found under the head of 'Belmont-Pamplemousses Longitude.'

The last operations connected with longitude in Mauritius were made for determining the errors of the chronometers before starting on the homeward run, for an account of which the reader is referred to Chapter VIII.

The members of the German Transit of Venus Commission and Mr. Gill sailed from Mauritius in the Messageries steamer 'Dupleix' on the afternoon of January 8, and reached Réunion the following morning. Two chronometers belonging to the Dutch expedition were at once brought on board by Dr. Oudemans, and compared with Lord Lindsay's chronometers. The errors of the Dutch chronometers had been determined on the previous night. Thus the difference of longitude between Réunion and Belmont was determined. The same evening the 'Dupleix' left Réunion for Aden, taking the members of the Dutch expedition —Oudemans (chief), Kaiser, Bakhuyzen, jun., and Soeters—as passengers. On the evening of January 13 the 'Dupleix' dropped anchor off Mahé, Seychelles; but unfortunately was put in quarantine for having touched at Réunion, where several cases of measles were said to have broken out.

This unfortunate circumstance prevented any landing to determine time; and but for the energy of Captain Wharton, of H.M.S. 'Shearwater' (which happened to be at Seychelles at the time), the opportunity of fixing the longitude of this group of islands would have been lost, or at least could only have been determined with the limited accuracy of sextant observations with a sea horizon. At first all communication whatever with the island was strictly prohibited; but at last, after much negotiation, Captain Wharton obtained permission to receive two chronometers, provided they were previously disinfected and allowed to drift astern in a boat with the wind, a rope being attached to the boat to haul it back again. So the chronometers, having been duly sprinkled with vinegar, were put in the boat and drifted off to Captain Wharton, who conveyed them on board his ship, compared them with his own chronometers, and returned them to the boat, which was then hauled back. Captain Wharton and his officers had observed equal altitudes of the sun on that day, and did so on the following day. The very satisfactory results thus obtained will be found in the 'Seychelles-Aden Longitude.' The following morning the 'Dupleix' sailed from Seychelles, and on the evening of January 20 reached Aden. Some chronometers and instruments were landed, and time was determined on the same night.

At Aden it was found that the 'Dupleix' had orders to remain there for ten days, to wait for cargo, and then to proceed to Marseilles for repairs. Thus it became possible, if favoured by the weather, &c., to finish the necessary work at Aden during the stay of the 'Dupleix,' and then to proceed to Suez by the same vessel without transshipping the chronometers. Accordingly Dr. Löw (chief of the German Mauritius Transit of Venus Commission) left Aden on the fol-

lowing day (January 21) by another Messageries steamer, and reached Suez on January 27. He proceeded at once to build a pier for his transit instrument on the site of the foundation which had been arranged for by Mr. Gill, and carefully executed under the kind superintendence of the Austrian consul. On the evening of Saturday, January 30, all was in readiness, and Dr. Löw commenced observations. Meanwhile Mr. Gill had secured several series of observations for time at Aden, so that exchanges of signals for longitude were begun after midnight on Saturday, January 30. On the evening of Sunday, the 31st, signals were again exchanged between Aden and Suez, and again on the early morning of Monday. It was only on Sunday that it was possible to obtain the use of the telegraph cable, and even then it was often necessary to wait some hours for an opportunity to exchange signals. The weather at Aden was very cloudy, and opportunities for observing were few and unsatisfactory; so that it would have been very desirable, if an extremely precise longitude had been required, to wait for further exchanges. But this would have involved another week's delay as well as transshipment of the chronometers. During Mr. Gill's stay at Aden signals were also exchanged by him on Sunday evening and early the following morning with Mr. Chambers, jun., at Bombay. It so happened that Mr. Gill had met Mr. Chambers, of the Bombay Observatory, on the outward voyage as a fellow passenger in the 'Mirzapore,' and had suggested to him the possibility of making a determination of the longitude of his observatory by an exchange of signals with him when at Aden. It was thus that a correspondence was commenced between Mr. Chambers, Director of the Bombay Observatory, and Mr. Gill, which afterwards ended in the determination of the longitude above referred to. The details of these determinations will be found under the head of 'Bombay-Aden Longitude.'

On Monday afternoon, February 1, Mr. Gill sailed from Aden, and arrived at Suez on February 8. Here he found Dr. Löw. Observations were made the same afternoon and evening both by Dr. Löw and Mr. Gill for time and personal equation. Similar observations were made on the 9th, and on the 10th observations were made for personal equation in sending and receiving signals by an artificial cable.

On the 11th Dr. Löw was prostrated by illness, brought on by fatigue; so Mr. Gill undertook to connect the observing station in the enclosure belonging to the Messageries Impériales with the British Government station.[3]

Accordingly the altazimuth was conveyed to Mr. Hunter's station; and observing there with that instrument, and at the other station with Dr. Löw's transit instrument, Mr. Gill determined the difference of longitude between the two stations by transport of chronometers. The details of this operation are given in Chapter XV. Mr. Gill then left for Alexandria, and erected his instrument on the stone roof of the Hôtel de l'Europe, on the site occupied by Mr. Hunter's transit instrument when that gentleman was engaged in the telegraphic operations under Sir George Airy for finding the longitude of Alexandria and Cairo from Greenwich.

On February 19, 20, 23, 24, and 25 signals were exchanged between Suez and Alexandria, and then Dr. Löw came on to Alexandria. Here, on March 3, he again compared personal

[3] When Mr. Hunter arrived in Suez for the purpose of observing the transit of Venus, he did not consider the station selected by Mr. Gill for his longitude purposes a suitable site for observing the transit. He accordingly selected another station (near the flagstaff at the Governor's summer residence), and it was the longitude of this station which he determined.

equation with Mr. Gill, and Mr. Gill also observed to determine his difference of personal equation when observing with his own instrument and that of Dr. Löw.

Meanwhile, on February 27 and 28, signals had been nightly exchanged between Prof. Auwers at Berlin and Mr. Gill at Alexandria; but the weather was not favourable for getting accurate time.

On March 6, 7, and 10 signals were also exchanged between Prof. Auwers and Mr. Gill. By March 11 Dr. Löw had reached Malta and established his observatory there, and the same night signals were exchanged between Malta and Alexandria, and Malta and Berlin. On March 12, 13, and 14 signals were exchanged between Alexandria and Malta, Malta and Berlin, and Berlin and Alexandria direct. On March 15 the exchanges were confined to Malta-Berlin, and the same night Mr. Gill determined the latitude of the station at Alexandria. The following day Mr. Gill measured a series of azimuths of well-known points in the city, by which the position of the site could afterwards be exactly identified. This concluded the longitude operations as far as the connection of Mauritius with a known European longitude is concerned. The final result, however, rests on a wider basis.

Dr. Copeland observed a number of moon culminations at Mauritius with the reversing transit instrument, and a considerable number of occultations were observed by Lord Lindsay, Dr. Copeland, and Mr. Davis. The independent determination of the longitude of Rodriguez by altitudes and transits of the moon by the British Transit of Venus party, and the determination of the longitude of Rodriguez by occultations by the Dutch party, afford additional checks on the main longitude by the chronometric connection of these stations with Belmont or Pamplemousses.

Mauritius being the centre of a group of observing stations, we were anxious that the determination of its longitude should be as accurate as possible. As far as we were aware the observers at the neighbouring stations—Rodriguez (English), Réunion (Dutch), and Mauritius (German)—intended to rely solely on observations of the moon.

Looking to the experience of the Americans, we could not coincide in the opinion that by this method the longitude could be obtained within a second of time.

Dr. Gould, in his account of the transatlantic longitude, determined by submarine cable by the expedition of the Coast Survey in 1866,[4] gives the following note of previous determinations of the longitude of Washington :—

I. From Observations of Eclipses and Occultations.

	h.	m.	sec.
Walker ('Coast Survey Report,' 1851), from observations before 1843 . . .	5	8	11·14
Pierce ('Coast Survey Report,' 1861), from eclipse of 1851, July 28 . . .			11·57
Pierce ('Coast Survey Report,' 1861), from emersions of Pleiades, 1839, September 26			11·45 ± 0·3
Pierce ('MS. Coast Survey Report'), from emersions of Pleiades, 1856–1861 . .			13·13

II. From Moon Culminations.

	h.	m.	sec.
Walker ('Coast Survey Report,' 1851), from Cambridge observations, 1843–1845 .	5	8	10·01
Loomis ('Trans. Amer. Phil. Soc.' x.), from Hudson observations, 1838–1844 . .			9·3
Gilliss ('Wash. Obs.,' 1862, vii.), from Capitol Hill, 1838–1842			10·04
Walker ('Coast Survey Report,' 1851), from Washington, 1845			9·60
Newcomb ('Wash. Obs.,' 1862, lii.), from Washington, 1846–1860 . . .			11·6 ± 0·4
Newcomb ('Wash. Obs.,' 1864), from Washington, 1862–1863			9·8

[4] *Smithsonian Contributions to Knowledge*, No. 223, vol. 16.

III. From Chronometers transported between Boston and Liverpool.

	h.	m.	sec.
Indiscriminate [5] mean from 373 chronometers previous to 1849	5	8	12·46
Bond's [6] discussion of 175 chronometers, expedition of 1849			11·14
Walker's [5] discussion of 175 chronometers, expedition of 1849			12·00
Bond's [7] discussion of 175 chronometers, expedition of 1849			12·20 ± 0·20
Bond's [8] discussion of 52 chronometers, 6 trips, expedition of 1855 . . .			13·43 ± 0·19

Dr. Gould remarks on these as follows (*loc. cit.* p. 5) :—

'The discordance of results which individually would have appeared entitled to full reliance is thus seen to exceed four seconds; the most recent determinations, and those which would be most relied upon, being among the most discordant.'

The longitude of Washington deduced from telegraphic exchange is $5^h\ 8^m\ 12^s{\cdot}39$. Professor Newcomb assigned $5^h\ 8^m\ 11^s{\cdot}1$ as the most probable value indicated by the moon culminations observed at the Naval Observatory from 1846 to 1863 inclusive. The mean of the chronometric results is very nearly in accordance with the telegraphic result; nor, indeed, does the mean of the results deduced from occultations of stars differ much from the true result.

It would appear, therefore, that the transport of chronometers, and occultations of stars by the moon, afford, when telegraphic communication is not available, the methods least liable to systematic error for the determination of longitudes.

Considering the possibility of failure in securing a sufficient number of occultations so arranged as to eliminate the errors of diameter, due to irradiation and irregularities of the moon's limb, we were induced to attempt the chronometric connection of Aden and Mauritius, and to determine the longitude of the former station by exchange of telegraphic signals.

The method of determining differences of longitude by means of the transport of chronometers has been employed successfully in several great operations, notably in the following :—

1843 { By Struve, connecting Pulkowa and Altona, 68 chronometers, 8 double trips.
1843 { By Struve, connecting Altona and Greenwich.
1843 { By Airy, connecting Greenwich and Valentia.

1849, 1850, 1851 } By Bond, connecting Cambridge, U.S., and Liverpool.

1855. By Bond, connecting Cambridge, U.S., and Liverpool, 3 double trips.

Besides these there have been the later chronometric expeditions under Otto Struve for the determination of longitudes in various parts of Russia. From all these much valuable information was obtained.

The problem before us was, however, of a much more difficult character. True, the same precision is not demanded in this result, but the conditions under which the experiments had to be made were much less favourable.

In all the above-mentioned operations the chronometers were carried from station E. to station W., then from W. to E., then from E. to W., then W. to E., and so on, the journeys following each other as rapidly as possible.

Thus if the temperature is uniform and other conditions known to affect the rate remain unaltered, the rate is obtained from the time the chronometer leaves the station W. till it returns

[5] *Coast Survey Report*, 1851. [6] *Ibid.* 1850. [7] *Ibid.* 1854. [8] *Ibid.* 1856.

to W. again. Another determination of rate is obtained each time the chronometer leaves E. and returns to the same station: thus a series of overlapping rates is obtained, from which the rate for each journey can be interpolated with the greatest accuracy. Besides this the operations were conducted under conditions extremely favourable as to temperature; the temperature being nearly uniform throughout the journeys or slowly changing.

In arranging results derived from so many observations, it was thought best to adhere as closely as might be to chronological order, although it was first necessary to reduce all the telegraphic longitudes to find the rates of the chronometers during their transport between the stations whose longitudes had thus been determined. To this rule it is necessary to make an exception in the case of the chronometer trials, half of which were made after the return from Mauritius. Ample particulars of these trials, together with an explanation of the principles on which they were conducted, are given in the next chapter.

CHAPTER I.

THE TEMPERATURE CORRECTIONS OF THE CHRONOMETERS.

To develope in any high degree the accuracy that can be attained in chronometric longitudes, it is now sufficiently admitted that it is essential to take the effects of temperature into account.

That we might be provided with the data for so doing, it became necessary to collect the chronometers some time in advance of the expedition, and to find means of testing them in different temperatures.

In order to procure a sufficient number of chronometers, application was made, in the first place, to the Admiralty; but, on account of the great demand for these instruments in connection with the Government Transit of Venus expeditions, it was found that none could be obtained from that source. By means of advertisements in various periodicals, and by personal application to the best makers, a large number of chronometers were at length borrowed or hired on trial. These instruments, as received, were sent to the Liverpool Observatory, and there subjected to preliminary trials, in order to test in some degree their fitness for use on the expedition.

And here we must express our obligations to Mr. Hartnup, not only for his ready help, but for the excellent arrangement of the appliances which he brought into use, and for the patience and skill with which the trials were carried out.

Some instruments were rejected as useless; the remainder, to the number of fifty, were retained, and their trials continued till their removal from Liverpool a few days before they left England *en route* for Mauritius.[1]

Determination of Temperature Corrections.

The 'Liverpool test,' or, in other words, the method which Mr. Hartnup has arrived at as the best adapted for a practical determination of the corrections of a chronometer, extends for a single test over five weeks.

During these five weeks the temperatures are arranged symmetrically.

	1st Week.	2nd Week.	3rd Week.	4th Week.	5th Week.
Thus:	55° F.	70° F.	85° F.	70° F.	55° F.
or	85° F.	70° F.	55° F.	70° F.	85° F.

The trials at 55° are conducted in a very large underground chamber, cut from the rock,

[1] After the expedition the chronometers were again brought to Liverpool and tested for temperature. In the trials preceding the expedition the chronometers were only exposed to three different temperatures, 55° F., 70° F., and 85° F.; but on the trials after the expedition they were tested at 55° F., 70° F., 85° F., and 95° F.

well ventilated and perfectly dry, where the temperature is nearly invariable. The trials at 70° and 85° are conducted in cases heated by gas jets and fitted with regulating apparatus, by which the temperature can be kept uniform within 1° F. for any required length of time. Mr. Hartnup then assumes that the rate of a chronometer can be represented by the formula—

$$R + C\,(T - t)^2 + na \qquad (1),$$

where T is the temperature of maximum gain,
R is the rate at temperature T,
C is a coefficient,
t is the temperature for which it is desired to know the rate,
a is the daily acceleration of the rate R,
n the number of days from the mean epoch.

The symmetrical arrangement of Mr. Hartnup's test eliminates the term na by simply taking for the data of calculation the mean of the rates at each of the three temperatures.

In this assumption of the best expression for the law of compensation of an ordinary chronometer Mr. Hartnup has followed M. Lieussou, and there is abundant evidence in the published experiments of these gentlemen and others that this law is at least approximately correct. But the practical development which Mr. Hartnup has given to M. Lieussou's method is in the selection of three equally distant temperatures for testing chronometers, and the means which his ingenuity has devised for preserving these temperatures uniform for a long period.

We shall refer afterwards at more length to the practical importance of this feature of the Liverpool test; in the meanwhile we must go back to the more general conditions which affect the rates of chronometers, and to the results of other investigators on the same subject.

The most elaborate theoretical investigation on the rates of chronometers is that of M. Yvon Villarceau ('Ann. de l'Obs. Imp. de Paris, Mémoires,' t. vii.)

The author enters at great length into the theoretical movements of the laminæ of an ordinary compensation balance, and the effects of errors in the adjustment of the isochronism of the balance spring.

But the conclusions at which he arrives are simply that the rate is a function of two variables—*the time* and *the temperature*—and that Taylor's theorem gives a ready means of finding the rate in terms of these variables.

If r is a mean rate at any mean temperature θ, and any time t, the relation between r, the rate at any other temperature θ', and any other time t' may be expressed by Taylor's theorem as follows:—

$$r' = r + \frac{dr}{dt}(t' - t) + \frac{dr}{d\theta}(\theta' - \theta) + \frac{d^2r}{d\theta^2}\frac{(\theta' - \theta)^2}{1\cdot 2} + \frac{d^2r}{dtd\theta}\left(\frac{t' - t}{1}\right)\left(\frac{\theta' - \theta}{1}\right) + \frac{d^2r}{dt^2}\frac{(t' - t)^2}{1\cdot 2} + \ldots$$

If the rate is capable of being expressed by any regular curve, then it is obvious that it can be expressed in terms of t and θ, if we take into account a sufficient number of terms of this series. And also we can find the value of r' for any values of t and θ, if we have observations of the rate at sufficiently different values of t and θ on as many occasions as the number of terms of the series which it is necessary to employ.

All formulæ which have been given from time to time by different writers to express the rates of chronometers are simply the employment of more or less of the terms of the above series.

Lieussou's original formula is simply a transformation of the first, third, and fourth terms. Hartnup's formula, including his term *na*, is simply the first four terms of Lieussou's formula.

The whole question, therefore, turns practically upon the results of trial as to how many terms it is desirable to take into account. A valuable paper on this very subject has recently been published by Lieutenant-Commander C. H. Davis, jun., U.S.N., issued as Appendix III. of the 'Washington Observations' for 1875. As this work anticipates much we had intended to publish on the subject, we need not repeat it here. We prefer rather to give the results of our own trials and the steps of reasoning by which we were led to adopt the method of reduction we have employed. And we shall endeavour at the same time to indicate how these errors can be best allowed for in computation, and also make such suggestions as, from our experience, we believe will be beneficial in the future use and construction of chronometers.

We have divided the causes which may affect the rate of a chronometer into three classes.

a. Errors which result from change of temperature.

b. Changes in those errors, or other changes which develope in the course of time.

c. Accidental errors.

a. Errors which result from Change of Temperature.

The results of Mr. Hartnup's trials at Liverpool, published annually in considerable detail for the very large number of chronometers which are tested at Liverpool, show conclusively, for the ordinary compensation balance at least (which is the construction usually employed in the merchant service), that the compensation is by no means perfect. When the balance is adjusted to perfect compensation for two extreme temperatures, it will be found to be over-compensated in the mean temperatures, and Lieussou,[2] Davis,[3] and others have shown pretty conclusively that within moderate limits the secondary error varies as the square of the temperature counted from the temperature of maximum gain.

The construction of the ordinary compensation balance is too well known to require description, and it would be quite unnecessary to refer farther to the matter were this form alone adopted. But, in order to overcome this outstanding error of compensation, many contrivances have been adopted.

Some of these, except as regards their delicacy, and consequent liability to change of form from slight concussions, are undoubtedly useful, and tend to diminish, and in some cases practically to eliminate, what we may call the *irrationality of the compensation.* In particular the balance invented by Mr. Hartnup (see 'Monthly Notices of the Royal Astronomical Society,' vol. ix. p. 206), and the vertical-armed balance of Mr. Kullberg, seem in some cases to be sensibly perfect in compensation.

But there is another class of balance, known as the auxiliary compensation balance, which, *except for chance prize-winning purposes,* is utterly objectionable. A common form of this class is simply an ordinary compensation balance, but provided with a curb or strong spring, against which the free end of the compensation laminæ comes in low temperatures. By means of a

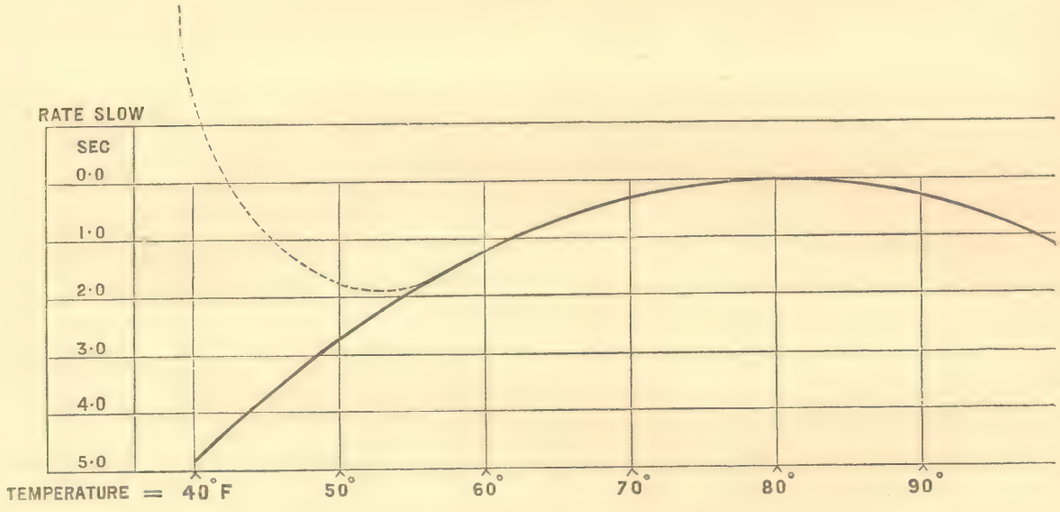
[2] *Recherches sur les variations de la marche des pendules et des chronomètres*, par M. Aristide Lieussou. Paris, 1854. For a report on this work, see *Additions à la Connaissance des Temps pour l'an* 1856.

[3] Appendix iii., *Washington Obs.*, 1875.

screw this contact can be made to occur at any desired temperature. We can best illustrate the effects of the action of this curb by referring to the accompanying diagram. The solid curve represents the effect of temperature on an ordinary chronometer adjusted for a maximum gaining rate (R) at 80°, when the value of $c = 0^s{\cdot}003$. The co-ordinates of the curve are the temperature and the rate.

But let us suppose that the maker has introduced a curb, adjusted so as to come into action at 55°. Let us now follow the action of the balance in a decreasing temperature. From the higher temperatures down to 55° the rate will be that of an ordinary chronometer, adjusted for a rather high point of maximum gain. At 55° the curb comes into action, but at first it does not stop the motion of the weights outwards, for the curbs have a certain amount of spring, and so have the laminæ of the balance. But as the temperature continues to fall and the weights to recede farther and farther from the centre, the yielding of the curb becomes less and less, and finally ceases. The effect is to produce rates below 55°, represented by the dotted curve, which finally runs off into practically a straight line, showing a gain of 5 or 6 seconds a day for each decrease of 1° F., i.e. equivalent to the rate of an uncompensated chronometer.

FIG. 1.



One can see from the diagram that, by such a contrivance, it is easy enough to produce complete compensation at three points. (We have, for example, in the diagram a losing rate of 1 second per day at each of the three temperatures 46°, 62°, and 98°.) Now, if a chronometer-maker chances to have a chronometer so adjusted, and it happens to be tested near those three temperatures only, he comes off with flying colours. But at what a price is this *apparent* perfection of compensation secured!

We have a curve of rate which is of the most uncertain character, and which it is practically impossible to compute, a curve whose errors increase with fearful rapidity after a certain temperature limit is passed, a curve liable to excessive derangement by the least shock, or by a minute particle of dust getting between the point of the screw and the curb.

It so happens that no extreme case of this auxiliary correction occurs in any chronometer employed in the expedition, but the reader will find some instances in which it has been useful to bear these considerations in mind. In dealing, then, with the temperature corrections of a

chronometer, it is necessary to consider the form of its balance, and this we have endeavoured to do. There are other considerations, however, which must be taken into account in determining the temperature coefficients.

For example, is it quite certain that all chronometer balances are perfectly elastic? i.e. is it certain that the same balance will always have the same form at the same temperature? Thus if the temperature of a balance is raised from 55° to 70°, and again if it is lowered from 85° to 70°, will the form of the balance be exactly the same at 70° in the two cases? At first sight this question appears to be capable of a very direct solution by a trial of the rate at 70° under each of these two circumstances, but it is by no means certain that the state of the oil will be the same under the two conditions. Oil at 70°, whose temperature has been lowered from 85° to 70°, is probably somewhat different in its lubricating properties from oil which has been raised in temperature from 55° to 70°.

There are so many curious and difficult questions which arise whenever we have to deal with the effect of oil upon chronometer rates, that it is impossible to deal fully with them all.

We know, however, as a fact that very many chronometers do not return to the same rate at the same temperature in short intervals of time. Thus, for example, we shall have

Rate at 70° $= r - s$ if the temperature has been raised from 55° to 70°,
and $= r + s$ if the temperature has been lowered from 85° to 70°.

This s is the *time equivalent* of what we shall call the *set of the balance.* Apart from considerations as to the state of the oil in the two cases, this *set* seems to arise from a sluggishness or imperfect elasticity of the balance, and invariably, when well marked, it has the same sign. That is, the chronometer, while maintained at 70°, will go faster if the previous temperature has been 55° than if it had been 85°. The effect, in fact, is the same as if the balance had not acted sufficiently in either case, but lagged, as it were, behind the compensation.

But we have also found that *two apparently similar chronometers, by the same maker, and lubricated at the same time with the same oil,* have shown great differences in the amount of this *set.* The natural conclusion is, that independently of oil there is a real *set* in one of the balances at least.

We have discussed this matter at great length with some of the best makers, and find that several of them have independently arrived at very similar conclusions. We have also made the subject one of rather extended experiment.

The result of all these experiments is simply this:—

1. That if a chronometer balance has *set,* in order to find the temperature factor it is essential to test the chronometer both in ascending and descending temperatures, and it is desirable that the test should extend a few degrees beyond the range of temperature to which the chronometer will probably be exposed.

2. That the best thing of all is to try to get chronometers which have not this *set* of the balance, and this has led us to investigate the causes which produce this *set,* and to endeavour to suggest a mode of manufacture by which it may be overcome.

In order that the reader may follow this more easily it is necessary to explain the ordinary mode of making compensation balances.

1. A disc of steel is bored, put upon an arbor, and carefully turned to the proper diameter and thickness.

2. Having been duly cleaned, this disc is put in a crucible together with fragments of brass and a proper flux. The crucible is then heated in a furnace till the brass melts. On cooling, a button of brass is found, surrounding and brazed upon the steel.

3. The brass is removed from the sides of the disc by careful filing; the hole in the centre of the steel disc is cleared from the stopping employed to protect it, and the disc is once more placed upon an arbor and the brass-covered edge is turned true.

4. But the brass now surrounding the steel is by no means in a fit state for working. It is well known that re-melted brass is never equal in quality to that originally made from copper, tin, and zinc; and, moreover, all brass before it is worked on a small scale must be well hammered, otherwise it is soft and porous. Hence the next process is to hammer the disc on the edge as uniformly as possible, a process requiring much practice and skill. The disc is then again put upon an arbor and turned till the brass edge is quite true and of the required thickness.

5. The disc is now a short cylinder of steel surrounded by a thin parallel cylinder of brass. The next step is to turn out the centre of the steel disc into the form of a hollow disc, of which the bottom is flat and the side vertical, the side being of thin steel surrounded by a somewhat thicker coating of brass.

In section thus—

FIG. 2.

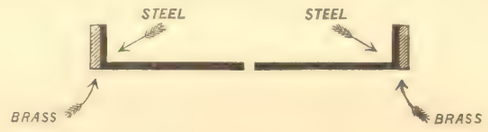
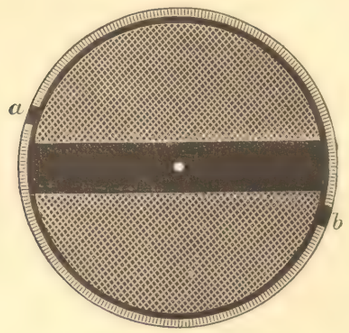


FIG. 3.



6. Segments of the bottom of the disc are now filed away (the parts so filed away are shown in fig. 3, indicated by cross shading), leaving an arm to support the ring so formed.

The ring is then cut at *a* and *b*, leaving the laminæ at liberty to take such form as will leave them in minimum tension.

On account of the hammering and other processes which the brass and steel have undergone, it very seldom happens that when the balance is cut it retains its circular form. The brass having been brazed to the steel in a state of fusion, and therefore at a very high temperature, the tendency on cooling (since the brass contracts more than the steel) is to cause the points of the laminæ at *a* and *b* to bend outwards when the rim is cut. The hammering of the brass, on the other hand, has a tendency to cause the same points to bend inwards, for the particles of brass soldered to the steel are not moved by hammering, whilst the tendency of

hammering is to wedge more particles of brass, as it were, over those attached to the steel, and so to create a tendency of the brass to elongate when free. By long practice the best balance-makers often manage to make these effects counteract each other, and the balances then remain nearly true when cut. It is much more generally the case that this is not so.

7. The weights which are to constitute the compensating mass in the balance are now fitted, and if the rim of the balance is not truly circular it is made so, or nearly so, by careful bending.

Now a balance so made is very apt to have a good many faults in the metal and construction. It is not good either for steel or for brass to be heated up to such a temperature before use. The brass particularly is very liable to be much injured, and the zinc to be burnt out of it. Neither is there any certainty that the junction between steel and brass is perfect, and there is great liability to destroy the soundness of that junction by the hammering process, and also to produce inequalities in the brass.

We believe, and some of the best practical men with whom we have discussed the matter coincide in the opinion, that the following plan for making balances would be preferable :—

1. The steel part of the balance should be completed as far as possible, hardened and tempered, but not cut.

2. A thin hollow cylinder of fine brass should then be made to fit accurately, but easily, upon the outside of the steel wheel.

3. The outside of the steel wheel and the inside of the brass cylinder should then be 'tinned' by any of the well-known methods. (To 'tin' a surface means to coat it with a thin adhering film of soft solder.)

4. The steel wheel and the hollow brass cylinder should then be gently heated, employing resin or some other flux to make the solder run. The brass cylinder should then be slipped over the steel wheel, and the two worked together till the practised eye can make certain of a perfect melting in common of the solder upon both surfaces. All is then allowed to cool.

In this way a good workman could always make certain of having a perfect junction between the steel and the brass ; the steel would have the advantage of being hardened and tempered,[4] which in chronometer balances it never is, and the good quality of the brass would be preserved.

5. On cutting the balance, even if the laminæ no longer remain quite circular, we recommend that they should be left as they are without any attempt to alter them by bending, as in this way they will be more likely to retain a permanent form.

So much for the remedy we recommend for *set* ; it is a practical one, and its worth can only be tested by experiment.

b. Errors which arise gradually after Lapse of Time.

We now come to a second class of errors, which arise after lapse of time, which are not to be traced to the effects of temperature, and which are not due to shocks or to accidental injury.

These have various sources, of which we have—

[4] It is, perhaps, a question whether the advantage of hardening and tempering the steel might not be more than counteracted by the greater liability of the balances to become permanent magnets when subjected to occasional magnetic influences. This is a question for practical trial, but the process is equally applicable to soft steel.

1. *Changes in the Oil.*—This, of all difficulties in dealing with chronometers, is the greatest. No two makers are agreed as to the best oil for use; but the fact remains that no one can employ many chronometers for any length of time without finding very strange and important errors traceable to this cause. Oil thickens, and its lubricating properties change by lapse of time. Probably, from combination with oxygen, its chemical constitution changes.

Suppose that the balance spring is adjusted so that when perfectly fresh oil is used, long vibrations and short vibrations of the balance are performed in the same time; this perfect adjustment of the isochronism of the spring will no longer remain good when the oil thickens. For if the balance pivots rotate in jewel holes lubricated with a perfectly limpid oil, or in the same jewel holes with the same balance and balance spring, and the same pivots lubricated with a very viscous oil, part of the force of the balance spring will in the latter case have to be expended in overcoming the viscosity of the oil, and therefore the balance will swing more slowly—just as if the balance spring had been weakened.

But when the oil in a chronometer becomes viscous, less force is communicated through the train of wheels to the escapement wheel; hence from this cause, as well as from the viscosity of the oil in the balance-pivot holes, the balance will swing in a smaller arc. Chronometer-makers take advantage of this fact, and create so far an artificial compensation of error by adjusting the balance springs, so that the chronometers would go fast in short arcs of vibration. They endeavour to make them go just so much faster in a diminished arc of vibration as a viscosity of the oil, such as would reduce the arc of vibration by the same amount, would cause the balance to go slow. This practice is quite general, but the result of experience is by no means the same.

Of course to some extent the experience of different makers in this respect must depend on the description of oil employed by them. All confess to great difficulty. Not only is it difficult to get good oil that will remain perfectly fluid for some considerable time, but suitable oil, even if once made, cannot always be reproduced by the same processes.

We found in the possession of Mr. Hartnup a chronometer which had been left at the Liverpool Observatory during the American civil war for the purpose of being rated. Of this chronometer Mr. Hartnup had a record of the daily rate for ten years, during which period it had never been cleaned. This rate we give on the accompanying page in a graphic form, because it illustrates much that we have to say on chronometers generally. There is abundant evidence that the oil of this chronometer was nearly perfect. There are no sudden changes, no inexplicable jumps, but only a gradual acceleration of rate which has gone on steadily from first to last. After the return of this chronometer from Mauritius, and after it had been tested a second time at Liverpool, at our request Mr. Hartnup had this instrument cleaned. The oil was found to be perfectly limpid and pure, and the instrument might safely have been left to go on as before.

In the diagram of its rate (opposite) the spots upon the dotted line indicate the actual rates for the mean of each five weeks' trial, combined in pairs of rising and falling temperature, to eliminate *set*, at 55°, 70°, and 85°. It happens that the maximum gaining temperature of this chronometer is very high (about 94° F.); in other words, the chronometer is over-compensated for ordinary temperatures. Thus at 55° the instrument goes slow, and continually faster up to 85°, and at 94° it would go fastest of all.

The solid lines indicate what the rate would be if an absolutely constant temperature co-

DIAGRAM OF THE RATE OF CHRONOMETER FOR TEN YEARS.

To face page 16.

Rate.

−3ˢ·8
−3ˢ·6
−3ˢ·4
−3ˢ·2
−3ˢ·0
−2ˢ·8
−2ˢ·6
−2ˢ·4
−2ˢ·2
−2ˢ·0
−1ˢ·8
−1ˢ·6
−1ˢ·4
−1ˢ·2
−1ˢ·0
−0ˢ·8
−0ˢ·6
−0ˢ·4
−0ˢ·2
0ˢ·0
+0ˢ·2
+0ˢ·4
+0ˢ·6
+0ˢ·8
+1ˢ·0
+1ˢ·2

Rate at 85°F.

Rate at 70° F.

Rate at 55° F.

1867, Feb. 13, to 1868, May 20. | *1868, July 1, to 1869, Oct. 6.* | *1869, Nov. 17, to 1871, Feb. 22.* | *1871, April 5, to 1872, July 24.* | *1872, Sept. 4, to 1873, Dec. 10.* | *1874, Jan. 21, to 1875, June 9.*

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efficient were assumed throughout. The three solid lines are in fact three parallel lines so drawn as to make the sum of squares of the divergence from the actual rates a minimum. The very accurate agreement of the two sets of lines is a remarkable proof of the constancy of the temperature coefficient through all these years.

The following table also shows this very well.

	Rate at			Effect of temperature		Difference from minimum	
	55°	70°	85°	70°–55°	70°–85°	70°–55°	70°–85°
	s.	s.	s.	s.	s.	s.	s.
1867 1868 Feb. 13 to May 20	+0·67	−1·29	−2·02	−1·96	+0·73	−0·11	+0·06
1868 1869 July 1 to Oct. 6	+0·14	−1·55	−2·29	−1·69	+0·74	+0·16	+0·07
1869 1871 Nov. 17 to Feb. 22	+0·33	−1·57	−2·28	−1·90	+0·71	−0·05	+0·04
1872 1872 April 5 to July 24	−0·39	−2·21	−2·76	−1·82	+0·55	+0·03	−0·12
1872 1873 Sept. 4 to Dec. 10	−0·88	−2·68	−3·34	−1·80	+0·66	+0·05	−0·01
1874 1875 Jan. 21 to June 9	−0·86	−2·77	−3·41	−1·91	+0·64	−0·06	−0·03

If all chronometers were lubricated with such oil, then M. Villarceau's term in the series which includes multiples of the time and the temperature would have no existence.

But in most cases this is not so, and the reality of a term depending upon multiples of the time and temperature is proved by a comparison of the effects of temperature on the chronometers when tested before the expedition, when the oil was fresh, and after the expedition, when the oil had in many cases somewhat thickened.

The following table gives the difference of the effect of temperature on the rate in the trials at Liverpool when the oil was fresh (i.e. before the expedition) and when the oil had somewhat thickened (i.e. after the expedition).

Rotation No.	Col. I.	Col. II.	Rotation No.	Col. I.	Col. II.	Rotation No.	Col. I.	Col. II.	Rotation No.	Col. I.	Col. II.
	s.	s.		s.	s.		s.	s.		s.	s.
1	−0·38	−0·62	14	−0·20	−0·72	26	−1·06	−0·81	40	−0·87	−0·70
2	−1·21	+0·02	15	−0·22	−0·16	27	−1·35	+0·15	42	−0·68	+0·31
3	−0·52	−0·06	16	+0·73	−0·12	28	+0·11	−0·53	43	−3·43	−0·07
4	−1·51	−0·66	17	−0·44	−0·20	30	+0·16	−0·12	44	+0·36	−0·29
7	+0·12	−0·09	18	−0·49	−0·10	33	+2·36	−0·62	45	−0·69	−0·08
8	−0·99	−0·12	19	−1·48	−0·47	34	−1·26	+0·11	47	+0·60	−1·03
9	−0·55	−0·42	20	−3·30	+0·26	35	−0·50	−0·48	48	−0·95	−0·09
10	−1·60	−0·12	23	+0·89	+0·61	36	−2·81	−0·59	49	+0·09	−0·54
11	−0·86	−0·12	24	−1·73	−0·01	38	+0·56	+0·30	50	−1·43	−0·26
12	+0·97	−0·04	25	−1·61	−0·25	39	+1·40	+0·16	51	−1·11	−0·33
13	+0·30	−0·18									

If we put

r'_{55}, r'_{70}, r'_{85} to represent the mean rates at 55°, 70°, and 85°, from the trials at Liverpool before the expedition,

r''_{55}, r''_{70}, r''_{85} for the corresponding rates at Liverpool after the expedition,

then Column I. of the preceding table gives for each chronometer the value of

$$(r'_{70}-r'_{55})-(r''_{70}-r''_{55}),$$

and Column II. gives the value of

$$(r'_{70}-r'_{85})-(r''_{70}-r''_{85}).$$

In the above table + means that the chronometer is gaining, and − that the chronometer is losing. If we regard these differences as purely accidental, then we find that the mean irregularities due to thickening of oil are—

From 55° F. to 70° F.	and from 70° F. to 85° F.
1ˢ·02	0ˢ·32

Thus the irregularities produced on the temperature coefficient by thickening of the oil are more than three times greater in the lower temperatures (55° to 70°) than in the higher temperatures (70° to 85°).

If, instead of regarding these errors as accidental (i.e. taking the arithmetical mean of them), we take the algebraic mean, we find that the thickening of the oil has produced a considerable systematic difference in the temperature coefficient, viz.

for 55° to 70° the mean difference is	−0ˢ·58
for 70° to 85° „	−0ˢ·22

Here we see that the systematic effect of the thickening of the oil is also about three times greater for the lower than the higher temperatures.

The reasonable conclusion is that oil is much more altered in its viscosity by a change of temperature from 55° to 70°, than by a change from 70° to 85°.

Much beyond this conclusion it is indeed difficult to go. It is easy enough to see why a chronometer should go relatively slower at 55° with thickened oil, for the balance spring will have some of its available force expended in overcoming the additional friction, as before explained. The chronometer-maker has tried to counteract this by adjusting his balance spring with a tendency to gain somewhat in the shorter arcs of vibration, but our experience seems to show that, upon the whole, sufficient compensation of this kind has not been made for the kind of oil employed; for, as we have seen, the chronometers on the average lost 0ˢ·58 more from 70° to 55° in the second trial (when the oil was thick) than on the first trial (when the oil was fresh).

But, on the other hand, when the thickened oil is heated to 85°, and becomes more limpid than at 70°, we find a general tendency to go relatively slower at 85° in the second trial than in the first. Why is it that a tendency to accelerate does not set in?

It is true that the same form of balance spring which prevents the chronometer from going so much slow as it otherwise would in thickened oil, tends to prevent it going so much faster in the more limpid oil.

But we have entirely failed to see theoretically, why such a form of the balance spring, whose tendency to gain in short arcs is insufficient to overcome the effects of viscosity of the oil on a balance vibrating in an arc considerably diminished by thickened oil, should be more than sufficient to correct the tendency to go slower in an arc increased by an oil whose viscosity is diminished by temperature.

On p. 29 *et seq.* the mean results for each chronometer at each temperature are given, deduced from symmetrically arranged trials at Liverpool.

These data will enable the reader to examine the question for himself.

The following table is also very instructive and useful. It gives the probable error of the daily rate of each chronometer independent of temperature—that is to say, the probable error of the daily rate in a uniform temperature. In discussing the merits of chronometers this point is frequently forgotten. It is frequently assumed that an instrument not affected by shocks, in uniform temperature and uniform conditions generally, will continue to have a uniform rate. This is by no means the case. The regularity of rate will depend upon the mechanical perfection of the instrument—upon a hundred technical details which it is impossible to describe separately here. In selecting a chronometer for scientific purposes the first condition of all is to obtain an instrument of high mechanical perfection, an instrument that under the same circumstances will have as nearly as possible the same rate. Such a table of probable errors is one of the best possible guides in the preliminary selection of a chronometer. It has been computed as follows :—

Let R_o represent the mean rate for the week,
ΔR_1 the difference of the 1st day's rate from R_o,
ΔR_2 „ „ 2nd „ „
ΔR_3 „ „ 3rd „ „
&c. &c. &c.

then the probable error of the daily rate in a uniform temperature is

$$\pm 0{\cdot}674 \sqrt{\frac{\Delta R_1^2 + \Delta R_2^2 + \Delta R_3^2 + \Delta R_4^2 + \Delta R_5^2 + \Delta R_6^2}{5}}$$

by which formula the probable error of rate for each week has been rigidly computed. The probable errors so found were then combined in groups of the same temperature, whence the following table (see next page).

It is true that these figures contain, besides the errors of the chronometer, the errors of comparison and the error of the determination of the rate of the standard clock. Both these errors combined, we are convinced, do not amount together to a probable error of $\pm 0^s{\cdot}04$, if so much.

In order that the reader may better appreciate the care with which these matters are determined at Liverpool, we give the following remarks and table (see p. 21) furnished by Mr. Hartnup :—

'At the Liverpool Observatory there are two clocks adjusted to sidereal time, and one to mean solar time. These clocks are compared with each other daily by coincident beats, and the error of the normal mean-time clock is thus found in terms of each of the sidereal clocks. The following method has been adopted for keeping the normal clock to approximate Greenwich mean time :—When, from astronomical observations, it is found to be a fraction of a second fast or slow, a vessel containing small shot is removed from a projecting piece on the pendulum rod, and shot taken out or added, so as to change the rate and gradually bring the clock to correct time. It is not often found necessary to alter the rate of the normal clock between consecutive series of observations, and consequently the normal as well as the two sidereal clocks has been rendered available for carrying on the time. Duplicate comparisons of all the chronometers with the normal clock have been made daily, Sundays excepted. The clock errors found subsequently by astronomical observations have been applied to these comparisons, and the error and rate of each chronometer have thus been found from day to day.

PROBABLE ERRORS OF DAILY RATE IN UNIFORM TEMPERATURES AT LIVERPOOL.

	First Period. i.e. before the expedition				Second Period. i.e. after return from the expedition				
Chronometer	Mean P E.	P.E. at 55° F.	P.E. at 70° F.	P.E. at 85° F.	Mean P.E.	P.E. at 55° F.	P.E. at 70° F.	P.E. at 85° F.	P.E at 95° F.
	s.	s.	s.	s.	s.	s.	s.	s.	s.
1	±·15	±·19	±·14	±·11	±·20	± ·28	±·18	±·14	±·20
2	±·12	±·13	±·12	±·10	±.14	± ·15	±·08	±·10	±·21
3	±·10	±·11	±·10	±·08	±·15	± ·29	±·11	±·08	±·10
4	±·12	±·10	±·12	±·13	±·20	± ·33	±·11	±·20	±·17
7	±·18	±·17	±·16	±·21	±·16	± ·26	±·17	±·10	±·11
8	±·11	±·12	±·11	±·10	±·13	± ·25	±·12	±·10	±·06
9	±·10	±·10	±·12	±·09	±·23	± ·54	±·13	±·09	±·15
10	±·12	±·10	±·11	±·16	±·16	± ·16	±·23	±·15	±·09
11	±·17	±·11	±·22	±·17	±·14	± ·14	±·12	±·18	±·11
12	+·10	±·09	±·10	±·12	±·20	± ·12	±·18	±·23	±·25
13	±·13	±·12	±·13	±·13	±·19	± ·34	±·11	±·14	±·18
14	±·12	±·14	±·10	±·12	±·13	± ·17	±·07	±·11	±·16
15	±·22	±·26	±·23	±·18	±·15	± ·33	±·09	±·10	±·06
16	±·18	±·16	±·19	±·18	±·18	± ·19	±·09	±·15	±·31
17	±·11	±·09	±·11	±·13	±·09	± ·11	±·07	±·07	±·09
18	±·16	±·18	±·21	±·10	±·12	± ·13	±·13	±·12	±·10
19	±·14	±·18	±·10	±·13	±·16	± ·18	±·25	±·10	±·11
20	±·17	±·23	±·18	±·09	±·19	± ·32	±·11	±·12	±·21
21	±·17	±·24	±·13	±·13	±·19	± ·37	±·15	±·13	±·10
22	±·18	±·26	±·13	±·14	±·44	±1·18	±·22	±·14	±·22
23	±·22	±·18	±·27	±·22	±·29	± ·38	±·36	±·18	±·25
24	±·15	±·13	±·14	±·18	±·18	± ·26	±·16	±·16	±·15
25	±·16	±·23	±·14	±·10	±·18	± ·48	±·09	±·07	±·08
26	±·11	±·13	±·11	±·09	±·21	± ·25	±·17	±·12	±·30
27	±·18	±·17	±·18	±·19	±·15	± ·18	±·15	±·10	±·15
28	±·16	±·13	±·15	±·19	±·18	± ·23	±·13	±·16	±·20
29	±·19	±·21	±·19	±·17	±·64	±1·62	±·32	±·47	±·16
30	±·15	±·17	±·11	±·16	±·15	± ·16	±·15	±·15	±·14
31	±·17	±·17	±·13	±·22	±·82	± ·91	±·97	±·98	±·40
32	±·25	±·32	±·23	±·21	±·22	± ·41	±·18	±·15	±·13
33	±·15	±·14	±·16	±·15	±·18	± ·26	±·16	±·19	±·12
34	±·10	±·12	±·11	±·08	±·11	± ·13	±·13	±·08	±·08
35	±·09	±·07	±·09	±·10	±·15	± ·25	±·13	±·11	±·09
36	±·10	±·08	±·12	±·10	±·11	± ·14	±·10	±·11	±·09
37	±·09	±·09	±·09	±·09	±·22	± ·12	±·29	±·20	±·26
38	±·22	±·20	±·21	±·24	±·13	± ·13	±·14	±·12	±·13
39	±·34	±·29	±·43	±·30	±·33	± ·37	±·28	±·41	±·27
40	±·24	±·32	±·20	±·20	±·41	± ·56	±·39	±·48	±·19
41	±·13	±·09	±·13	±·17	...	...	...	...	...
42	±·08	±·08	±·10	±·07	±·14	± ·23	±·09	±·07	±·15
43	±·25	±·33	±·23	±·18	±·24	± ·44	±·16	±·20	±·16
44	±·13	±·15	±·12	±·12	±·15	± ·26	±·09	±·12	±·13
45	±·12	±·11	±·13	±·12	±·14	± ·11	±·11	±·26	±·09
46	±·18	±·23	±·18	±·13	±·23	± ·23	±·26	±·17	±·25
47	±·18	±·17	±·19	±·19	±·25	± ·33	±·32	±·17	±·17
48	±·23	±·12	±·29	±·27	±·24	± ·11	±·50	±·14	±·19
49	±·13	±·10	±·17	±·11	±·13	± ·11	±·10	±·23	±·08
50	±·10	±·07	±·13	±·11	±·10	± ·11	±·07	±·10	±·11
51	±·18	±·17	±·18	±·18	±·27	± ·18	±·24	±·18	±·46
52	±·08	±·04	±·11	±·10	±·10	± ·17	±·09	±·09	±·05
Mean	±·15	±·15	±·15	±·14	±·20	± ·30	±·18	±·17	±·16

The following table exhibits the daily error of each clock, and the adopted errors of the normal clock which have been used in finding the errors and rates of the chronometers during the months of June and July 1875, and may serve as an example of the going of the clocks.'

M., sid. clock by Molyneux. B., sid. clock by Bond. N., normal mean-time clock by Molyneux.

Date	M.	B.	Normal clock slow				Date	M.	B.	Normal clock slow			
Mean time	Slow	Slow	By M.	By B.	By N.	Adopted error	Mean time	Slow	Slow	By M.	By B.	By N.	Adopted error
June 1875.							July 1875.						
d. h. m.	s.	s.	s.	s.	s.	s.	d. h. m.	s.	s.	s.	s.	s.	s.
0 22 6	38·51	66·91	−0·62	−0·62	−0·62	−0·6	1 22 11	37·61	63·28	−0·75	−0·66	−0·61	−0·6
1 22 8	38·58	66·80	−0·40	−0·48	−0·33	−0·5	2 22 26	37·60	63·12	−0·79	−0·80	−0·74	−0·7
2 22 27	38·65	66·69	−0·06	−0·47	−0·03	−0·4	3 21 41	37·60	62·96	−0·88	−0·88	−0·88	...
3 0 47	38·67	66·67	0·00	0·00	0·00	...	4 21 54	37·58	63·07	−0·57	−0·57	−0·57	−0·6
3 22 16	38·49	66·59	0·04	−0·30	0·03	−0·2	5 22 1	37·45	62·99	−0·41	−0·37	−0·32	−0·4
4 22 48	38·27	66·53	−0·08	−0·08	−0·08	−0·1	6 22 32	37·32	62·91	−0·26	−0·18	−0·07	−0·2
6 22 8	38·13	66·33	0·33	0·15	0·28	0·2	7 22 11	37·19	62·83	−0·41	−0·31	−0·34	−0·4
7 22 21	38·06	66·23	0·46	0·46	0·46	0·4	8 22 2	37·05	62·75	−0·66	−0·64	−0·59	−0·6
8 22 10	37·87	66·08	0·51	0·42	0·41	0·4	9 22 17	36·91	62·68	−0·84	−0·84	−0·84	−0·8
9 22 6	37·69	65·93	0·48	0·41	0·35	0·4	10 23 12	36·60	62·54	−0·83	−0·89	−0·77	−0·8
10 22 19	37·50	65·77	0·60	0·44	0·30	0·4	11 22 6	36·30	62·40	−0·77	−0·78	−0·71	−0·7
11 22 8	37·32	65·62	0·67	0·38	0·24	0·4	12 21 48	36·00	62·26	−0·64	−0·64	−0·64	−0·6
13 22 7	36·95	65·31	0·35	0·18	0·13	0·2	13 22 7	36·01	62·12	−0·43	−0·55	−0·50	−0·5
14 22 4	36·76	65·16	0·07	0·07	0·07	0·1	14 22 21	36·03	61·97	−0·27	−0·41	−0·35	−0·4
15 22 13	36·73	64·95	0·04	0·04	0·04	0·0	15 21 47	36·04	61·82	−0·21	−0·21	−0·21	−0·2
16 22 10	36·96	64·80	0·13	0·10	0·13	0·1	16 21 55	36·23	61·82	0·11	0·11	0·11	0·1
17 22 8	37·19	64·65	0·18	0·12	0·26	0·2	18 22 18	36·20	61·64	0·17	0·10	0·18	0·1
18 22 11	37·42	64·50	0·37	0·37	0·37	0·4	19 22 14	36·18	61·55	0·27	0·31	0·32	0·3
20 22 16	37·57	64·42	0·50	0·50	0·50	0·5	20 22 34	36·16	61·46	0·43	0·56	0·47	0·5
21 22 13	37·59	64·37	0·49	0·44	0·47	0·4	21 22 11	36·14	61·36	0·69	0 84	0·61	0·8
22 22 59	37·61	64·32	0·46	0·43	0·44	0·4	22 21 49	36·12	61·14	0·67	0·67	0·67	0·7
23 22 19	37·63	64·27	0·42	0·42	0·42	0·4	23 21 15	35·66	60·99	0·33	0·33	0·33	0·4
24 22 5	37·63	64·19	0·18	0·18	0·18	0·2	25 21 49	34·61	60·77	0·49	0·49	0·49	0·5
25 22 8	37·63	64·25	0·19	0·19	0·19	0·2	26 22 7	34·29	60·75	0·65	0·52	0·56	0·6
27 22 5	37·63	63·93	0·46	−0·12	−0·08	−0·1	27 22 44	33·98	60·74	0·63	0·63	0·63	0·6
28 22 10	37·62	63·77	0·22	−0·33	−0·22	−0·2	28 22 9	33·71	60·71	0·62	0·54	0·54	0·5
29 22 27	37·62	63·61	−0·18	−0·40	−0·35	−0·3	29 22 5	33·44	60·67	0·46	0·45	0·45	0·4
30 22 25	37·61	63·44	−0·49	−0·48	−0·48	−0·5	30 22 7	33·17	60·63	0·35	0·35	0·36	0·3
							31 4 8	33·09	60·62	0·33	0·33	0·33	...

Probably some of the best chronometers might have shown a slightly diminished probable error if the observations had been absolutely simultaneous with the comparisons, and if the comparisons had been made by coincident beats; but, from the methods employed by Mr. Hartnup in carrying on the time between the observations, the high excellence of the clocks, and the great skill with which the double estimations are made, it is quite certain that the differences would not sensibly affect the conclusions we can draw from the table.

We see, in the first place, prominently that with fresh oil the chronometers go equally well at the three temperatures in which they were tested.

For the whole of the chronometers the average probable error of the daily rate for the first period is as follows :—

55°	70°	85°
±0ˢ·15	±0ˢ·15	±0ˢ·14

Most of the chronometers had then only been going three or four months from the time they were cleaned till the conclusion of the trials.

On the return of the chronometers after the expedition, when the chronometers had been exposed to great changes of temperature, and to climates very dry (as in Egypt) and very moist (as in the Red Sea), the average probable errors were

55°	70°	85°	95°
±0ˢ·30	±0ˢ·18	±0ˢ·17	±0ˢ·16

We find now, that the probable errors are considerably increased, but this is specially observable in the lowest temperature.

It is not difficult to trace the cause of this. When oil has thickened by oxidation or otherwise, its viscosity seems to be variable, or it may arrange itself round the pivot in circular layers of varying viscosity; and these layers, when disturbed by outside movement (as when the chronometer is disturbed to be wound), do not arrange themselves quite as before, and thus produce irregularity. Hence the greater errors in general with thickened oil. Also when oil has thickened it seems to lose its viscosity at high temperatures, to melt and become, in fact, like new or fresh oil. This being so, the chronometer is restored nearly to the condition of a freshly cleaned instrument at high temperatures, whilst at lower temperatures the viscosity of the oil plays its detrimental part. A glance down the column of the probable errors, which have been much increased by thickened oil in the second period (as in Nos. 22, 29, 31, &c.), will show this effect in a remarkable degree.

As far as our enquiries and experience go, the oils least subject to thickening by time are some of the purified fish oils. Their chief fault is an extreme fluidity, and consequent liability to run away from the pivots. This could be entirely overcome by the employment of properly formed holes with end covers on all the pivots. With very fluid oil much extra care is required in having the holes perfectly clean (chemically) and perfectly dry, and especially in oiling only the proper places with the proper amount of oil. With these precautions we do not doubt that the most fluid oil could be used without fear.

2. But there are other errors besides those due to oil, which arise from the lapse of time alone. Such errors are those which might be supposed to arise from a gradual self-polishing of the locking points and pivots, producing a greater mechanical perfection and increasing the arc of vibration; or, on the other hand, a gradual cutting or wear, producing the reverse effect. Such errors are possible. In a well-made chronometer, with good jewelled pallets and good workmanship throughout, the former influence is not likely to be sensible; and a neglect to oil a pivot will produce the second effect. This latter, however, must be classed amongst accidents and accidental errors, with which we shall afterwards deal.

But there is another source of errors depending on time.

Every new chronometer with a well-hardened balance spring gains upon its rate. This acceleration of rate is well known to every chronometer-maker, and many of the chronometers employed on the expedition show it in a marked degree. If a chronometer has been recently

sprung, in a few months it will generally be found to gain about four seconds daily on its original rate. In course of time the amount of this acceleration gradually diminishes, and finally, after some years, it disappears. The chronometer is now at its best, and continues so for years. If the spring is not well hardened and left of a good hard temper, a process of losing in its rate begins. The original acceleration is generally greatest in chronometers which ultimately prove to be the best. If there is no acceleration in a new chronometer, it is a fairly sure sign that the balance spring is soft, and the instrument will pretty surely prove ultimately to be a bad one.

By many writers the acceleration of new chronometers has been attributed to such causes as changes in the oil, polishing of the pivots and lockings by mutual action of the parts, but neither of these causes will account for it; for an old chronometer just cleaned and oiled does not gain on its rate in a like degree, but if a new balance spring is applied to an old chronometer all the phenomena of acceleration are shown precisely as in a new chronometer.

The true cause seems to be a molecular change which takes place in the steel of the balance spring. Some have maintained that this change only takes place in that part of the spring which is bent to form the eye of the spring (i.e. where the spring departs from a cylindrical helix). This bending is produced after the spring has been hardened and tempered; it is in the formation of this eye that the skill of the workman is shown, and on the form of this eye the adjustment for isochronism depends. If this be so, then if the eye were formed at the time when the spring is hardened, no acceleration would take place. We believe that attempts have been made, with partial success, to harden the eyes of springs along with the cylindrical part of the spring, but that the springs so produced accelerate just in the same way as others.

In the earlier stages of this acceleration chronometers never go steadily; their rates are liable to sudden change. This fact is so well recognised that the best makers never issue their chronometers till they have been going for a couple of years—until they 'settle down,' as the technical phrase is. In good chronometers the acceleration goes on for a longer period, though in a less degree; and perhaps a safe rule, if it could be carried out in future, would be that *no chronometer should be used for accurate longitude operations until it is six years old.*

It is a well-known fact amongst chronometer-makers that many a chronometer, which has ultimately been placed first on the list at Greenwich, has competed year after year in the Greenwich trials. At first the acceleration alone has placed the chronometer near the bottom of the list in the order of merit, but year after year the acceleration of rate has diminished, and finally the chronometer comes out at the top of the list.

c. Errors which arise suddenly or are due to Accident.

We have under this head an entirely different class of errors, the effects of which are of course beyond the reach of analysis. Of these we have—

1. The effects of shocks.

A shock may create errors of three kinds.

First. A simple jump or trip, causing a sudden change of error, but not followed by any change of rate.

Second. A small bending of the balance or alteration of position of the weights of the balance, producing no sensible sudden error, but a sudden sensible change of rate.

Third. The fracture of a jewel hole or the bending of a balance pivot, producing a change of rate, as well as an irregularity of rate, or even stoppage in the future.

The best way to avoid all these errors is of course to avoid shocks. This we endeavoured to provide for as far as possible in the mode of mounting and employing the chronometers (see p. 45), and at least we are certain that the precautions taken were successful in avoiding all the errors of the *third* kind. From the daily comparisons with the standard chronometer it is also evident that only three instances occurred of error of the *first* class. Whether any errors of the *second* class arose it is much more difficult to decide, and it is not impossible that some small errors have been caused in this way by transshipment. All chronometers are liable to such derangement. Auxiliary balances and some of the more complicated balances are peculiarly liable to it from their more fragile and jointed construction. On this ground we particularly advocate resort to the simplest and strongest forms of balance. Of these the ordinary balance seems to be the best; its residual errors are easily taken into account, and care should be taken that the laminæ are not made too thin, as they sometimes are, under the impression that their action will then be more perfect.

2. A pivot may be oiled with bad oil; the oil may have run away from the pivot; or oil may, by some oversight, not have been applied at all to some particular pivot.

So well are chronometer-makers aware of the defects of chronometer oil that they are continually trying experiments with different oils.

A favourite test of oil used to be to place a phial of the oil in a freezing mixture, or to expose it to the air on a night of sharp frost. If the oil still remained pure and clear, it was considered good. This led to a general employment of some nut oils, which bore this test remarkably well, but which yielded the most unsatisfactory results in practice.

Apparently, from exposure to the air, some chemical change took place in these oils; they first thickened, and finally became converted into a red powder, which ground and cut the pivots terribly, and finally stopped the chronometer.

Or again, if a very fluid oil is used, and if the holes and the neighbourhood of the holes are not made absolutely clean and free from grease before the oil is applied, or if too much oil is applied, so that the capillary attraction is not sufficient to retain all the oil round the pivot, the oil is apt to drain off and form a thin coating over the plate, so depriving the pivot of the amount of oil necessary for lubrication. The pivot soon begins to cut, adhesion takes place between the particles of the pivot and the hole, and a rapid increase of friction is the result, ending in time in the stoppage of the instrument.

Finally, it happens on rare occasions that in oiling the chronometer the workman omits to apply oil to one or more of the holes. This of course produces still more rapidly the evil effects of a dry hole, as just described.

3. The effect of magnetisation of the balance is often discussed. We believe that occasionally balances do, by some accident, become polarised, and that small errors are then produced when the position of the chronometer is changed. In the trials of the chronometers at Liverpool, however, we could detect no such tendency in any of the instruments. They were frequently changed in position in the same temperature, but no sensible change of rate could be detected.

Now if we consider the effects of these three causes of error, *a*, *b*, *c*, we see that two of these, *a* and *b*, are of a character which may, to a certain extent, be expressed as functions of the time

and temperature. It is true that the errors due to oil may not always be exactly so expressed, because, up to a certain point, oil remains tolerably pure and limpid. When chemical change begins, it generally goes on rapidly until a second stage or condition of oil is reached, which remains fairly constant for some time, and then perhaps there comes another change. Hence the changes of rate due to change in the oil are apt to take place by jumps, and so are also the changes in the temperature coefficient, as far as caused by change in the oil. The change of rate due to molecular change in the balance spring also takes place by jumps in the earlier stages, although in older chronometers it is very uniform.

If, then, we desire to express the rate of chronometers for a very long period, it is necessary (particularly if the balance spring is new and the oil faulty) to take a considerable number of terms into account, and even then we only arrive at a certain rounding off of the curve of actual rate, and hardly at a fair determination of legitimate coefficients.

The excellent discussion by Lieutenant-Commander Davis, U.S.N., published as Appendix III. to 'Washington Observations' for 1875 (Washington, 1878), shows that there is a certain advantage in taking a considerable number of terms into account. But it must not be forgotten that *these experiments were conducted in a fixed observatory, nor were the chronometers subjected to shocks, to damp, or to change of climate*, and we have shown how these circumstances may alter existing conditions very sensibly, and introduce errors not at all legitimately representable by a curve.

Even for the conditions of his experiments he found that the gain was very little in taking into account more terms than those employed by Lieussou, and that in fact the formula of Hartnup—our formula (1)—was practically the best, provided that its use is not extended over too long a period.

From the considerations already fully stated we arrived at a very similar conclusion to that of Mr. Davis.

For a practical method, we believe that which we have adopted to be the most satisfactory, viz.

1. To determine the best possible value of the temperature of maximum gain T and of the coefficient C from all the experiments, supposing R not to be controlled by any law, but liable to have been disturbed by shocks or other accident during the long interval between the trials preceding and following the expedition. During the period of each trial R was supposed to vary proportionally with the time—that is to say, the mean of determinations, symmetrically arranged as to temperature, was used for calculation. The easiest method of doing this was to find first by calculation for each chronometer the value of T from the first trials. Then, by the aid of a table of temperature coefficients,[5] with C and $(T-t)$ as arguments, such a value of C was found for each chronometer as would give the smallest residuals throughout both trials. In the second trial, because of thickening of the oil, small weight was given to the rate at 55°; hence in the values finally adopted it will be seen that the rate at 55° in the second trial is not very accurately represented. It was found, however, that the rates at 55°, 70°, and 85° in the first trial, and at 70°, 85°, and 95° in the second trial, could be pretty accurately represented with the same value of C and T in both trials. The final values of C and T were arrived at by a second approximation, in which sometimes the value of T was slightly changed from that rigidly found in the first trial. The results of the actual determinations, together with an account of each chronometer,

[5] Given overleaf.

TABLE OF FACTORS

Factor C.	Number of Degrees from Point of Maximum Gain												
	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°
·0015	0·00	0·01	0·01	0·02	0·04	0·05	0·07	0·10	0·12	0·15	0·18	0·22	0·25
·0016	...	0·01	0·01	0·03	0·04	0·06	0·08	0·10	0·13	0·16	0·19	0·23	0·27
·0017	...	0·01	0·02	0·03	0·04	0·06	0·08	0·11	0·14	0·17	0·21	0·24	0·29
·0018	...	0·01	0·02	0·03	0·05	0·06	0·09	0·12	0·15	0·18	0·22	0·26	0·30
·0019	...	0·01	0·02	0·03	0·05	0·07	0·09	0·12	0·15	0·19	0·23	0·27	0·32
·0020	0·00	0·01	0·02	0·03	0·05	0·07	0·10	0·13	0·16	0·20	0·24	0·29	0·34
·0021	...	0·01	0·02	0·03	0·05	0·08	0·10	0·13	0·17	0·21	0·25	0·30	0·35
·0022	...	0·01	0·02	0·04	0·06	0·08	0·11	0·14	0·18	0·22	0·27	0·32	0·37
·0023	...	0·01	0·02	0·04	0·06	0·08	0·11	0·15	0·19	0·23	0·28	0·33	0·39
·0024	...	0·01	0·02	0·04	0·06	0·09	0·12	0·15	0·19	0·24	0·29	0·35	0·41
·0025	...	0·01	0·02	0·04	0·06	0·09	0·12	0·16	0·20	0·25	0·30	0·36	0·42
·0026	...	0·01	0·02	0·04	0·06	0·09	0·13	0·17	0·21	0·26	0·31	0·37	0·44
·0027	...	0·01	0·02	0·04	0·07	0·10	0·13	0·17	0·22	0·27	0·33	0·39	0·46
·0028	...	0·01	0·03	0·04	0·07	0·10	0·14	0·18	0·23	0·28	0·34	0·40	0·47
·0029	...	0·01	0·03	0·05	0·07	0·10	0·14	0·19	0·23	0·29	0·35	0·42	0·49
·0030	0·00	0·01	0·03	0·05	0·08	0·11	0·15	0·19	0·24	0·30	0·36	0·43	0·51
·0031	...	0·01	0·03	0·05	0·08	0·11	0·15	0·20	0·25	0·31	0·38	0·45	0·52
·0032	...	0·01	0·03	0·05	0·08	0·12	0·16	0·20	0·26	0·32	0·39	0·46	0·54
·0033	...	0·01	0·03	0·05	0·08	0·12	0·16	0·21	0·27	0·33	0·40	0·48	0·56
·0034	...	0·01	0·03	0·05	0·09	0·12	0·17	0·22	0·28	0·34	0·41	0·49	0·57
·0035	...	0·01	0·03	0·06	0·09	0·13	0·17	0·22	0·28	0·35	0·42	0·50	0·59
·0036	...	0·01	0·03	0·06	0·09	0·13	0·18	0·23	0·29	0·36	0·44	0·52	0·61
·0037	...	0·01	0·03	0·06	0·09	0·13	0·18	0·24	0·30	0·37	0·45	0·53	0·63
·0038	...	0·02	0·03	0·06	0·10	0·14	0·19	0·24	0·31	0·38	0·46	0·55	0·64
·0039	...	0·02	0·04	0·06	0·10	0·14	0·19	0·25	0·32	0·39	0·47	0·56	0·66
·0040	0·00	0·02	0·04	0·06	0·10	0·14	0·20	0·26	0·32	0·40	0·48	0·58	0·68
·0041	...	0·02	0·04	0·07	0·10	0·15	0·20	0·26	0·33	0·41	0·50	0·59	0·69
·0042	...	0·02	0·04	0·07	0·11	0·15	0·21	0·27	0·34	0·42	0·51	0·60	0·71
·0043	...	0·02	0·04	0·07	0·11	0·15	0·21	0·28	0·35	0·43	0·52	0·62	0·73
·0044	...	0·02	0·04	0·07	0·11	0·16	0·22	0·28	0·36	0·44	0·53	0·63	0·74
·0045	...	0·02	0·04	0·07	0·11	0·16	0·22	0·29	0·36	0·45	0·54	0·65	0·76
·0046	...	0·02	0·04	0·07	0·12	0·17	0·23	0·29	0·37	0·46	0·56	0·66	0·78
·0047	...	0·02	0·04	0·08	0·12	0·17	0·23	0·30	0·38	0·47	0·57	0·68	0·79
·0048	...	0·02	0·04	0·08	0·12	0·17	0·24	0·31	0·39	0·48	0·58	0·69	0·81
·0049	...	0·02	0·04	0·08	0·12	0·18	0·24	0·31	0·40	0·49	0·59	0·71	0·83
·0050	0·00	0·02	0·05	0·08	0·13	0·18	0·24	0·32	0·40	0·50	0·60	0·72	0·84
·0051	0·01	0·02	0·05	0·08	0·13	0·18	0·25	0·33	0·41	0·51	0·62	0·73	0·86
·0052	0·01	0·02	0·05	0·08	0·13	0·19	0·25	0·33	0·42	0·52	0·63	0·75	0·88
·0053	0·01	0·02	0·05	0·08	0·13	0·19	0·26	0·34	0·43	0·53	0·64	0·76	0·90
·0054	0·01	0·02	0·05	0·09	0·14	0·19	0·26	0·35	0·44	0·54	0·65	0·78	0·91
·0055	0·01	0·02	0·05	0·09	0·14	0·20	0·27	0·35	0·45	0·55	0·67	0·79	0·93
·0056	0·01	0·02	0·05	0·09	0·14	0·20	0·27	0·36	0·45	0·56	0·68	0·81	0·95
·0057	0·01	0·02	0·05	0·09	0·14	0·21	0·28	0·36	0·46	0·57	0·69	0·82	0·96
·0058	0·01	0·02	0·05	0·09	0·15	0·21	0·28	0·37	0·47	0·58	0·70	0·84	0·98
·0059	0·01	0·02	0·05	0·09	0·15	0·21	0·29	0·38	0·48	0·59	0·71	0·85	1·00
·0060	0·01	0·02	0·05	0·10	0·15	0·22	0·29	0·38	0·49	0·60	0·73	0·86	1·01

FOR CHRONOMETERS.

Number of Degrees from Point of Maximum Gain													Factor C.
14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	25°	26°	
0·29	0·34	0·38	0·43	0·49	0·54	0·60	0·66	0·73	0·79	0·86	0·94	1·01	·0015
0·31	0·36	0·41	0·46	0·52	0·58	0·64	0·71	0·77	0·85	0·92	1·00	1·08	·0016
0·33	0·38	0·44	0·49	0·55	0·61	0·68	0·75	0·82	0·90	0·98	1·06	1·15	·0017
0·35	0·40	0·46	0·52	0·58	0·65	0·72	0·79	0·87	0·95	1·04	1·12	1·22	·0018
0·37	0·43	0·49	0·55	0·62	0·69	0·76	0·84	0·92	1·01	1·09	1·19	1·28	·0019
0·39	0·45	0·51	0·58	0·65	0·72	0·80	0·88	0·97	1·06	1·15	1·25	1·35	·0020
0·41	0·47	0·54	0·61	0·68	0·76	0·84	0·93	1·02	1·11	1·21	1·31	1·42	·0021
0·43	0·49	0·56	0·64	0·71	0·79	0·88	0·97	1·06	1·16	1·27	1·37	1·49	·0022
0·45	0·52	0·59	0·66	0·75	0·83	0·92	1·01	1·11	1·22	1·32	1·44	1·55	·0023
0·47	0·54	0·61	0·69	0·78	0·87	0·96	1·06	1·16	1·27	1·38	1·50	1·62	·0024
0·49	0·56	0·64	0·72	0·81	0·90	1·00	1·10	1·21	1·32	1·44	1·56	1·69	·0025
0·51	0·58	0·67	0·75	0·84	0·94	1·04	1·15	1·26	1·38	1·50	1·62	1·76	·0026
0·53	0·61	0·69	0·78	0·87	0·97	1·08	1·19	1·31	1·43	1·56	1·69	1·83	·0027
0·55	0·63	0·72	0·81	0·91	1·01	1·12	1·23	1·36	1·48	1·61	1·75	1·89	·0028
0·57	0·65	0·74	0·84	0·94	1·05	1·16	1·28	1·40	1·53	1·67	1·81	1·96	·0029
0·59	0·67	0·77	0·87	0·97	1·08	1·20	1·32	1·45	1·59	1·73	1·87	2·03	·0030
0·61	0·70	0·79	0·90	1·00	1·12	1·24	1·37	1·50	1·64	1·79	1·94	2·10	·0031
0·63	0·72	0·82	0·92	1·04	1·16	1·28	1·41	1·55	1·69	1·84	2·00	2·16	·0032
0·65	0·74	0·84	0·95	1·07	1·19	1·32	1·46	1·60	1·75	1·90	2·06	2·23	·0033
0·67	0·76	0·87	0·98	1·10	1·23	1·36	1·50	1·65	1·80	1·96	2·12	2·30	·0034
0·69	0·79	0·90	1·01	1·13	1·26	1·40	1·54	1·69	1·85	2·02	2·19	2·37	·0035
0·71	0·81	0·92	1·04	1·17	1·30	1·44	1·59	1·74	1·90	2·07	2·25	2·43	·0036
0·73	0·83	0·95	1·07	1·20	1·34	1·48	1·63	1·79	1·96	2·13	2·31	2·50	·0037
0·74	0·85	0·97	1·10	1·23	1·37	1·52	1·68	1·84	2·01	2·19	2·37	2·57	·0038
0·76	0·88	1·00	1·13	1·26	1·41	1·56	1·72	1·89	2·06	2·25	2·44	2·64	·0039
0·78	0·90	1·02	1·16	1·30	1·44	1·60	1·76	1·94	2·12	2·30	2·50	2·70	·0040
0·80	0·92	1·05	1·18	1·33	1·48	1·64	1·81	1·98	2·17	2·36	2·56	2·77	·0041
0·82	0·94	1·08	1·21	1·36	1·52	1·68	1·85	2·03	2·22	2·42	2·62	2·84	·0042
0·84	0·97	1·10	1·24	1·39	1·55	1·72	1·90	2·08	2·27	2·48	2·69	2·91	·0043
0·86	0·99	1·13	1·27	1·43	1·59	1·76	1·94	2·13	2·33	2·53	2·75	2·97	·0044
0·88	1·01	1·15	1·30	1·46	1·62	1·80	1·98	2·18	2·38	2·59	2·81	3·04	·0045
0·90	1·03	1·18	1·33	1·49	1·66	1·84	2·03	2·23	2·43	2·65	2·88	3·11	·0046
0·92	1·06	1·20	1·36	1·52	1·70	1·88	2·07	2·27	2·49	2·71	2·94	3·18	·0047
0·94	1·08	1·23	1·39	1·56	1·73	1·92	2·12	2·32	2·54	2·76	3·00	3·24	·0048
0·96	1·10	1·25	1·42	1·59	1·77	1·96	2·16	2·37	2·59	2·82	3·06	3·31	·0049
0·98	1·12	1·28	1·44	1·62	1·80	2·00	2·20	2·42	2·64	2·88	3·12	3·38	·0050
1·00	1·15	1·31	1·47	1·65	1·84	2·04	2·25	2·47	2·70	2·94	3·19	3·45	·0051
1·02	1·17	1·33	1·50	1·68	1·88	2·08	2·29	2·52	2·75	3·00	3·25	3·52	·0052
1·04	1·19	1·36	1·53	1·72	1·91	2·12	2·34	2·57	2·80	3·05	3·31	3·58	·0053
1·06	1·21	1·38	1·56	1·75	1·95	2·16	2·38	2·61	2·86	3·11	3·37	3·65	·0054
1·08	1·24	1·41	1·59	1·78	1·99	2·20	2·43	2·66	2·91	3·17	3·44	3·72	·0055
1·10	1·26	1·43	1·62	1·81	2·02	2·24	2·47	2·71	2·96	3·23	3·50	3·79	·0056
1·12	1·28	1·46	1·65	1·85	2·06	2·28	2·51	2·76	3·02	3·28	3·56	3·85	·0057
1·14	1·30	1·48	1·68	1·88	2·09	2·32	2·56	2·81	3·07	3·34	3·62	3·92	·0058
1·16	1·33	1·51	1·71	1·91	2·13	2·36	2·60	2·86	3·12	3·40	3·69	3·99	·0059
1·18	1·35	1·54	1·73	1·94	2·17	2·40	2·65	2·90	3·17	3·46	3·75	4·06	·0060

and the finally adopted values of T and C for each chronometer, are given in the table at the end of this chapter.

2. From these values of T and C a table was constructed for each chronometer, giving the value of $C(T-t)^2$ for each degree Fahrenheit from 55° to 95°.

3. To find the value of R for any particular period it is then necessary to find the temperature t for each day,[6] and to take from the table of values of $C(T-t)^2$ the corresponding correction to R for each day for each chronometer.

Then if

r . . . . = the mean daily rate of a chronometer deduced in the usual way for any particular period,

$k_1\ k_2\ k_3 \ldots k_n$ = the corrections to R taken from the table of temperature corrections as above explained,

and putting

$$\Sigma k = k_1 + k_2 + k_3 \ldots + k_n,$$

then

$$R = r - \frac{\Sigma k}{n} \text{ for the mean epoch } \theta \qquad (2).$$

If some time afterwards we obtain another independent determination of rate we shall have

$$R' = r' - \frac{\Sigma k'}{n'} \text{ for the mean epoch } \theta' \qquad (3).$$

For any time θ_0 lying between θ and θ' a corresponding value of maximum gaining rate, R_0, can be interpolated. This maximum rate has then to be reduced to the actual rate for each day by corrections dependent on the temperature as given by the chronometric thermometer.

TEMPERATURE COEFFICIENTS OF THE CHRONOMETERS.

The Chronometrical Thermometer.

This chronometer was constructed by W. Farquhar $\left(\frac{L}{7}\right)$: its compensation balance was, however, replaced by a simple brass one, in order that the change of rate should indicate the temperature.

After the second trial the arc of vibration and the oil were found in excellent condition. There seems to have been no considerable acceleration.

The mean daily rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−69·4	+28·5	+114·1	...
Second Trial	−57·8	+30·7	+132·3	+190·8

Considering the approximate determination of the temperature in the trials, we find these rates at any temperature can be sufficiently well represented by the formula

$$r = +30^s{\cdot}0 - 6^s{\cdot}24\ (70° - t),$$

where r is the required rate for the temperature t in degrees Fahrenheit.

[6] On account of the manner in which the chronometers were packed and the constancy of the temperature of the water surrounding the ship, the temperature of the chronometers was so constant, or at least changed so slowly, that in the longitude runs it was not necessary to separate the periods into shorter intervals than one day. The mean temperature from day to day was found by the rate of the chronometrical thermometer.

The residuals are—

	55°	70°	85°	95°	55°	70°	85°	95°
	s.	s.	s.	s.	°	°	°	°
First Trial . .	+5·8	+1·5	+9·5	...	−0·93	−0·24	−1·52	...
Second Trial . .	−5·8	−0·7	−8·7	−4·8	+0·93	+0·12	+1·39	+0·77

The following is the resulting table of equivalent rates and temperatures :—

Daily rate	Temp.	Daily rate	Temp.	Daily rate	Temp.	Daily rate	Temp.	Daily rate	Temp.
s.	°	s.	°	s.	°	s.	°	s.	°
−94·8	50	−32·4	60	+30·0	70	+ 92·4	80	+154·8	90
−88·6	51	−26·2	61	+36·2	71	+ 98·6	81	+161·0	91
−82·3	52	−19·9	62	+42·5	72	+104·9	82	+167·3	92
−76·1	53	−13·7	63	+48·7	73	+111·1	83	+173·5	93
−69·8	54	− 7·4	64	+55·0	74	+117·4	84	+179·8	94
−63·6	55	− 1·2	65	+61·2	75	+123·6	85	+186·0	95
−57·4	56	+ 5·0	66	+67·4	76	+129·8	86	+192·2	96
−51·1	57	+11·3	67	+73·7	77	+136·1	87	+198·5	97
−44·9	58	+17·5	68	+79·9	78	+142·3	88	+204·7	98
−38·6	59	+23·8	69	+86·2	79	+148·6	89	+211·0	99

Examples of the employment of the instrument to determine the mean temperature will be found throughout the whole of the chronometric longitude operations.

Rotation number, 1. *S. Quilliam.* 17917.

The balance is practically the ordinary compensation balance, with a projecting radial arm attached to the rim at the point of section, but its position is such that it could have no sensible influence on the compensation.

After the second trial the instrument was found in good condition and the oil apparently good.

The mean daily rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−0·04	−0·97	−0·48	...
Second Trial	[+0·49]	−0·82	+0·29	+1·43

Rejecting the results for 55° in the second trial, the deduced coefficients are—

$$C = 0^s{\cdot}0040 \qquad T = 72°.$$

The residuals and values of R are—

		55°	70°	85°	95°
	s.	s.	s.	s.	s.
First Trial	R, −1·12	−0·08	+0·13	−0·04	...
Second Trial	R, −0·64	−0·03	−0·16	+0·25	−0·05

From these coefficients the following table has been constructed by the formula

$$\text{Correction} = C(T - t)^2,$$

where t, the temperature for any interval of time, is the argument.

Similar tables have been constructed and used for all the chronometers for which coefficients were available, but it has been thought unnecessary to reproduce them.

Temperature	Correction	Temperature	Correction	Temperature	Correction	Temperature	Correction
55°	s. 1·16	65°	s. 0·20	75°	s. 0·04	85	s. 0·68
56	1·02	66	0·14	76	0·06	86	0·78
57	0·90	67	0·10	77	0·10	87	0·90
58	0·78	68	0·06	78	0·14	88	1·02
59	0·68	69	0·04	79	0·20	89	1·16
60	0·58	70	0·02	80	0·26	90	1·30
61	0·48	71	0·00	81	0·32	91	1·44
62	0·40	72	0·00	82	0·40	92	1·60
63	0·32	73	0·00	83	0·48	93	1·76
64	0·26	74	0·02	84	0·58	94	1·94

Rotation number, 2. *G. H. & C. Gowland.* 2724.

The balance is of the ordinary form.

After the second trial the arc of vibration and the oil were found good.

The mean daily rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−1·55	−2·89	−3·22	...
Second Trial	[−1·45]	−4·00	−4·35	−3·78

Rejecting the results for 55° in the second trial, the deduced coefficients are—

$$C = 0^{s}\cdot0027 \qquad T = 83^{\circ}.$$

The residuals and values of R are—

		55°	70°	85°	95°
	s.	s.	s.	s.	s.
First Trial	R, −3·42	−0·25	+0·07	+0·19	...
Second Trial	R, −4·33	...	−0·13	−0·03	+0·16

Rotation number, 3. *D. McGregor & Co.* 2004.

The balance appears to be a modification of Molyneux's balance, with an additional action coming into effect in cold. There are many objections to such a balance as this. Firstly, from the extreme difficulty of finding the temperature where the auxiliary comes into play, and consequently the difficulty of finding the law of compensation. Secondly, the great liability to derangement of so delicate an adjustment. We find this exemplified in the present instance.

After the second trial the arc of vibration was found good, but the oil somewhat discoloured.

The mean daily rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−2·70	−1·87	−1·70	...
Second Trial	−7·16	−7·46	−7·24	−6·95

In the first trials we have an instrument for which, if regarded as an ordinary balance chronometer, we should have $C = -0^{s}\cdot0009$; $T = 47^{\circ}$; in other words, the ordinary law of the compensation balance reversed, and an abnormally small factor.

The result of the second trial would, on the other hand, indicate a factor C of the usual sign, but of very small amount, and the point T about 75°. It appears from these facts that

somewhere between 55° and 70° this auxiliary comes in to check the over-compensation of the balance. We can therefore only apply the ordinary law of the balance as deduced from temperatures of 70° and upwards.

The deduced coefficients are—

$$C = 0^{s}\cdot0025 \qquad T = 75^{\circ}.$$

For temperatures below 65° the correction has been assumed the same as at 65°.

Rotation number, 4. *D. McGregor & Co.* 2034.

The balance is the ordinary compensation balance.

After the second trial the arc of vibration and the oil were found to be good.

The mean daily rates are—

	55°	70°	85°	95
	s.	s.	s.	s.
First Trial	−2·20	−2·26	−1·24	...
Second Trial	[−1·23]	−2·80	−1·13	+0·28

Rejecting the results for 55° in the second trial, the deduced coefficients are—

$$C = 0^{s}\cdot0030 \qquad T = 64^{\circ}.$$

The residuals and values of R are—

	s.	55°	70°	85°	95°
		s.	s.	s.	s.
First Trial	R, −2·45	+0·01	+0·08	−0·11	...
Second Trial	R, −2·66	...	−0·25	+0·21	+0·06

Rotation number, 7. *D. McGregor & Co.* 2253.

The balance is known as the Pooler balance, in which a small screw curbs the action of the balance except in extreme heat, or, if the screw is not brought to touch, will curb the action of compensation in extreme cold. It appears from the rates that this curb has not come into action at all.

After the second trial the arc of vibration and the oil were satisfactory.

The mean daily rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−2·07	−2·99	−2·68	...
Second Trial	−5·03	−5·82	−5·42	−4·50

The deduced coefficients are—

$$C = 0^{s}\cdot0028 \qquad T = 73^{\circ}.$$

The residuals and values of R are—

	s.	55°	70°	85°	95°
		s.	s.	s.	s.
First Trial	R, −3·03	+0·05	+0·01	−0·05	...
Second Trial	R, −5·86	−0·08	+0·01	+0·04	0·00

Rotation number, 8. *D. McGregor & Co.* 2513.

The balance is the ordinary compensation balance.

After the second trial the oil was found slightly discoloured, the arc of vibration fairly good.

The mean daily rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−0·63	−1·45	−1·04	...
Second Trial	[−2·35 −0·88]	−3·42	−2·89	−2·00

Rejecting the results for 55° in the last trial, the deduced coefficients are—

$$C = 0^s{\cdot}0029 \qquad T = 72^\circ.$$

The residuals and values of R are—

	s.	55°	70°	85°	95°
		s.	s.	s.	s.
First Trial	R, −1·48	+0·01	+0·02	−0·05	...
Second Trial	R, −3·44	...	+0·01	+0·06	−0·09

Rotation number, 9. *D. McGregor & Co.* 2514.

The balance is of the ordinary construction.

After the second trial the arc of vibration and oil seemed good.

The mean daily rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−1·32	−1·82	−1·14	...
Second Trial	[−2·87]	−3·92	−2·82	−1·73

Rejecting the results for 55° in the second trial, the deduced coefficients are—

$$C = 0^s{\cdot}0030 \qquad T = 69^\circ.$$

The residuals and values of R are—

	s.	55°	70°	85°	95°
		s.	s.	s.	s.
First Trial	R, −1·87	−0·04	+0·05	−0·04	...
Second Trial	R, −3·75	...	−0·17	+0·16	−0·01

Rotation number, 10. *D. McGregor & Co.* 2517.

The balance is similar to that of number 3, and the same remarks apply exactly to this chronometer.

After the second trial the arc of vibration and oil were found good.

The mean daily rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−2·72	−2·44	−2·07	...
Second Trial	−4·23	−5·55	−5·06	−4·33

The deduced coefficients, neglecting entirely, as in 3, the results at 55°, are—

$$C = 0^s{\cdot}0025 \qquad T = 73^\circ.$$

Rotation number, 11. *D. McGregor & Co.* 3072.

The balance is of the ordinary construction.

After the second trial the arc of vibration was good, the oil slightly discoloured.

The mean daily rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−1·70	−2·65	−2·44	...
Second Trial	[−7·59]	−9·40	−9·07	−8·73

Rejecting the results for 55° in the second trial, the coefficients are—

C=0ˢ·0030 T=76°.

The residuals and values of R are—

	s.	55° s.	70° s.	85° s.	95° s.
First Trial	R, −2·81	−0·19	+0·05	+0·13	...
Second Trial	R, −9·54	...	+0·03	+0·23	−0·25

Rotation number, 12. *D. McGregor & Co.* 4571.

The balance is of the ordinary construction.

After the second trial the arc of vibration was good, the oil somewhat discoloured. A low weight has been given to the rates of the second trial, as they are very irregular.

The resulting coefficients (neglecting results for 55° in the second trial) are—

C=0ˢ·0025 T=66°.

The residuals and values of R are—

	s.	55° s.	70° s.	85° s.	95° s.
First Trial	R, −0·21	+0·06	−0·10	+0·03	...
Second Trial	R, +0·29	...	+0·14	+0·24	−0·39

Rotation number, 13. *D. McGregor & Co.* 4572.

The balance is of the ordinary construction.

After the second trial the arc of vibration and oil were found to be excellent.

The mean rates are—

	55° s.	70° s.	85° s.	95° s.
First Trial	+0·87	+0·05	−0·18	...
Second Trial	[+0·98]	+0·47	+0·41	+0·78

The deduced coefficients (rejecting the values for 55° in the second trial) are—

C=0ˢ·0015 T=80°.

The residuals and values of R are—

	s.	55° s.	70° s.	85° s.	95° s.
First Trial	R, −0·13	+0·07	+0·03	−0·09	...
Second Trial	R, +0·38	...	−0·06	−0·01	+0·06

Rotation number, 14. *D. McGregor & Co.* 5724.

The balance is of the ordinary construction.

After the second trial the arc of vibration and oil were found to be excellent.

The mean rates are—

	55° s.	70° s.	85° s.	95° s.
First Trial	−0·31	−1·27	−0·96	...
Second Trial	−0·80	−1·96	−0·93	+0·03

The deduced coefficients are—

C=0ˢ·0030 T=71°.

The residuals and values of R are—

	s.	55° s.	70° s.	85° s.	95° s.
First Trial	R, −1·29	+0·22	+0·02	−0·25	...
Second Trial	R, −1·67	+0·12	−0·29	+0·17	−0·01

Rotation number, 15. *J. Sewell.* 4035.

The balance is of the ordinary construction.

After the second trial the arc of vibration and oil were found fairly good.

The mean rates are—

	55° s.	70° s.	85° s.	95° s.
First Trial	+0·87	−0·52	−0·48	...
Second Trial	−0·15	−1·77	−1·56	−0·82

The deduced coefficients are—

C=0ˢ·0033 T=77°.

The residuals and values of R are—

	s.	55° s.	70° s.	85° s.	95° s.
First Trial	R, −0·70	−0·02	+0·02	+0·01	...
Second Trial	R, −1·83	+0·09	−0·10	+0·07	−0·05

Rotation number, 16. *J. Sewell.* 4036.

The balance is of the ordinary construction.

After the second trial the arc of vibration had considerably diminished; the oil was rather thick.

The mean rates are—

	55° s.	70° s.	85° s.	95° s.
First Trial	−0·43	−1·45	−0·74	...
Second Trial	[−1·70]	−1·97	−1·14	+0·23

Rejecting the results for 55° in the second trial, the coefficients are—

C=0ˢ·0036 T=70°.

The residuals and values of R are—

	s.	55° s.	70° s.	85° s.	95° s.
First Trial	R, −1·44	+0·20	−0·01	−0·11	...
Second Trial	R, −1·98	...	+0·01	+0·03	−0·04

Rotation number, 17. *J. Sewell.* 4046.

The balance is of the ordinary construction.

After the second trial the arc of vibration and oil were found to be very good.

The mean rates are—

	55° s.	70° s.	85° s.	95° s.
First Trial	−2·99	−3·63	−3·04	...
Second Trial	−3·77	−4·85	−4·06	−3·00

The deduced coefficients are—

C=0 ·0033 T=71°.

The residuals and values of R are—

	s.	55° s.	70° s.	85° s.	95° s.
First Trial	R, −3·71	−0·12	+0·08	+0·03	...
Second Trial	R, −4·76	+0·15	−0·09	+0·06	−0·13

Rotation number, 18. *J. Sewell.* 4047.

The balance is of the ordinary construction.
After the second trial the arc of vibration was good, the oil discoloured.
The mean rates are—

	55° s.	70° s.	85° s.	95° s.
First Trial	−3·15	−4·20	−3·61	...
Second Trial	[−2·26]	−2·82	−2·13	−1·13

Rejecting the results for 55° in the second trial, the coefficients are—

C=0^{s}·0032 T=72°.

The residuals and values of R are—

	s.	55° s.	70° s.	85° s.	95° s.
First Trial	R, −4·14	+0·07	−0·07	−0·01	...
Second Trial	R, −2·77	...	−0·06	+0·10	−0·05

Rotation number, 19. *S. Quilliam.* 19613.

The balance is similar to that of *number* 1.
After the second trial the arc of vibration was fair; the oil was somewhat discoloured.
The mean rates are—

	55° s.	70° s.	85° s.	95° s.
First Trial	−0·31	−1·25	−0·98	...
Second Trial	$\left[\begin{matrix}-0\cdot37\\+2\cdot07\end{matrix}\right]$	−1·57	−0·83	−0·20

Rejecting the results for 55° in the second trial, the coefficients are—

C=0^{s}·0036 T=74°.

The residuals and values of R are—

	s.	55° s.	70° s.	85° s.	95° s.
First Trial	R, −1·44	−0·16	+0·13	+0·03	...
Second Trial	R, −1·56	...	−0·07	+0·30	−0·23

Rotation number, 20. *S. Quilliam.* 19615.

The balance is similar to that of *number* 1.
After the second trial the arc of vibration and oil were found fairly good.
The mean rates are—

	55° s.	70° s.	85° s.	95° s.
First Trial	−1·49	−3·99	−3·95	...
Second Trial	−5·07	−9·87	−10·09	−9·62

It is impossible to find coefficients to satisfy these rates.

Rotation number, 21. *S. Quilliam.* 19616.

No particulars whatever are given of this chronometer.

Rotation number, 22. *J. Walker.* 184.

After the second trial the arc of vibration had much diminished ; the oil was found discoloured. No description of balance given.

The mean rates are—

	55°	70°	85°
	s.	s.	s.
First Trial	−4·50	−4·17	−2·57
Second Trial		Rejected	

The deduced coefficients are—

$$C = 0^{s}\cdot0035 \qquad T = 61^{\circ}.$$

Rotation number, 23. *J. Walker.* 204.

The balance is of the ordinary construction.

After the second trial the arc of vibration was very small and the oil discoloured.

The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−3·34	−2·89	−1·22	...
Second Trial	[−2·66	−1·32	−0·26	+1·20]

Rejecting the results of the second trial entirely, the coefficients are—

$$C = 0^{s}\cdot0030 \qquad T = 59^{\circ}.$$

Rotation number, 24. *Reid & Sons.* 1249.

The balance is similar to that of *number* 7.

After the second trial the arc of vibration and oil were found very good.

The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−1·53	−2·90	−2·93	...
Second Trial	[−5·25 / −3·61]	−7·52	−7·54	−6·81

Rejecting the results for 55° in the second trial, the coefficients are—

$$C = 0^{s}\cdot0030 \qquad T = 78^{\circ}.$$

The residuals and values of R are—

		55°	70°	85°	95°
	s.	s.	s.	s.	s.
First Trial	R, −3·10	−0·01	0·00	+0·02	...
Second Trial	R, −7·69	...	−0·02	0·00	+0·01

Rotation number, 25. *T. Russell and Son.* 2147.

The balance is of the ordinary construction.

After the second trial the arc of vibration was found to have considerably diminished ; the oil was discoloured.

The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	+1·13	−1·24	−2·22	...
Second Trial	[−0·17]	−4·15	−4·88	−4·75

Rejecting the results for 55° in the second trial, the coefficients are—

C = 0ˢ·0036 T = 87°.

The residuals and values of R are—

	s.	55°	70°	85°	95°
		s.	s.	s.	s.
First Trial	R, −2·32	−0·24	+0·04	+0·09	...
Second Trial	R, −5·02	...	−0·17	+0·13	+0·04

Rotation number, 26. *J. & A. Harris.* 1500.

The balance is of the ordinary construction.

After the second trial the arc of vibration and oil seemed fairly good.

The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	+3·66	+3·79	+4·94	...
Second Trial	[+0·02]	−0·89	+1·05	+2·37

Rejecting the results for 55° in the second trial, the coefficients are—

C = 0ˢ·0030 T = 62°.

The residuals and values of R are—

	s.	55°	70°	85°	95°
		s.	s.	s.	s.
First Trial	R, +3·49	+0·02	+0·10	−0·13	...
Second Trial	R, −0·82	...	−0·27	+0·29	−0·08

Rotation number, 27. *Reid & Sons.* 1697.

The balance is similar to that of *number* 7.

After the second trial the arc of vibration and oil were apparently good.

The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	+2·68	+1·86	+2·70	...
Second Trial	[−1·11]	−3·28	−2·59	−0·47

Rejecting the results for 55° in the second trial, the coefficients are—

C = 0ˢ·0040 T = 70°.

The residuals and values of R are—

	s.	55°	70°	85°	95°
		s.	s.	s.	s.
First Trial	R, +1·81	−0·03	+0·05	−0·01	...
Second Trial	R, −3·25	...	−0·03	−0·24	+0·28

Rotation number, 28. *H. P. Isaac.* 1126

The balance is similar to that of *numbers* 7, 24, and 27; and here, again, the auxiliary action is troublesome, rendering the computation of the constants difficult.

After the second trial the arc of vibration and oil were apparently good.

The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−1·32	−1·87	−1·00	...
Second Trial	−1·92	−2·36	−0·96	+0·65

The deduced coefficients are—

$$C = 0^{s}\cdot0032 \qquad T = 67^{\circ}.$$

The residuals and values of R are—

		55°	70°	85°	95°
	s.	s.	s.	s.	s.
First Trial	R, −1·90	+0·12	0·00	−0·14	...
Second Trial	R, −2·15	−0·23	−0·24	+0·15	+0·29

Rotation number, 29. *H. P. Isaac.* 3130.

No description of the balance given; the chronometer stopped before the end of the second trial. The maker afterwards reported that one of the pivots was broken.

The rates even of the first trial are not accordant; not satisfactory coefficients can be found.

Rotation number, 30. *T. Russell & Son.* 2156.

The balance is of the ordinary construction.

After the second trial the arc of vibration and the oil were found good.

The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−4·87	−6·05	−5·29	...
Second Trial	−11·15	−10·69	−9·64	−8·30

The deduced coefficients are—

$$C = 0\cdot0040 \qquad T = 72^{\circ}.$$

The residuals and values of R are—

		55°	70°	85°	95°
	s.	s.	s.	s.	s.
First Trial	R, −6·01	−0·02	−0·06	+0·04	...
Second Trial	R, −10·63	[−1·68]	−0·08	+0·31	+0·21

Rotation number, 31. *Brock.* 1166.

The balance is of the ordinary construction.

After the second trial the arc of vibration was much diminished; the oil was much discoloured.

The mean rates are—

	55°	70°	85°
	s.	s.	s.
First Trial	+2·00	+2·19	+2·90
Second Trial		Rejected	

The deduced coefficients are—

$$C = 0^{s}\cdot0015 \qquad T = 60^{\circ}.$$

Rotation number, 32. *Brock.* 1254.

The results of this chronometer cannot be expressed by any law. No description of the balance is given.

Rotation number, 33. *T. Russell & Son.* 2159.

After the second trial the arc of vibration was found good ; the oil was discoloured.

The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−0·18	−0·51	+0·73	..
Second Trial	[−5·04	−3·01	−1·15	+0·72]

Rejecting the second trial altogether, the coefficients are—

$$C = 0^{s}\cdot0036 \qquad T = 66^{\circ}.$$

Rotation number, 34. *V. Kullberg.* 1232.

The balance is Kullberg's split balance, the effect of it being to check the action somewhat in cold.

After the second trial the arc of vibration was found to be good ; the oil was somewhat discoloured.

The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	+1·10	+0·36	+0·74	...
Second Trial	[+2·91]	+0·91	+1·18	+1·78

Rejecting the results for 55° in the second trial, the coefficients are—

$$C = 0^{s}\cdot0023 \qquad T = 72^{\circ}.$$

The residuals and values of R are—

	s.	55°	70°	85°	95°
		s.	s.	s.	s.
First Trial	R, +0·38	+0·06	−0·03	−0·02	...
Second Trial	R, +0·76	...	+0·14	+0·04	−0·19

Rotation number, 35. *V. Kullberg.* 1772.

The balance is of the ordinary construction, with an auxiliary.

After the second trial the arc of vibration and oil were found in fairly good condition.

The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−1·00	−1·22	−1·23	...
Second Trial	−0·75	−1·47	−1·10	−0·50

The adopted coefficients from the trials at 70°, 85°, and 95° are—

$$C = 0^{s}\cdot0025 \qquad T = 77^{\circ}.$$

The residuals and values of R are—

	s.	55°	70°	85°	95°
		s.	s.	s.	s.
First Trial	R, −1·36	[−0·85]	+0·02	−0·03	...
Second Trial	R, −1·39	[−0·57]	−0·20	+0·13	+0·08

The residuals show the influence of the auxiliary at 55° to be $+0^{s}\cdot70$; and, for want of a better theory, it is assumed to be $0^{s}\cdot01$ at 62°, and to vary uniformly between these limits. This correction has been taken into account in the table for this chronometer.

Rotation number, 36. *V. Kullberg.* 2138.

The balance is Kullberg's split balance.

After the second trial the arc of vibration had somewhat diminished; the oil seemed good.

The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	[−0·38]	−1·09	−1·89	...
Second Trial	[+1·01]	−2·51	−2·72	−2·23

We can only rely on this chronometer in the higher temperatures; therefore, rejecting the results at 55°, the coefficients are—

$$C = 0^{s}\cdot0030 \qquad T = 82^{\circ}.$$

The residuals and values of R are—

		55°	70°	85°	95°
	s.	s.	s.	s.	s.
First Trial	R, −1·71	...	+0·19	−0·21	...
Second Trial	R, −2·83	...	−0·11	+0·08	+0·09

Rotation number, 37. *V. Kullberg.* 2854.

The balance is Kullberg's flat-rim balance.

After the second trial the arc of vibration had much diminished; the oil was thick. Therefore the rates in the second trial have been rejected.

The mean rates are—

	55°	70°	85°
	s.	s.	s.
First Trial	−0·67	−0·55	−0·28

The deduced coefficients are—

$$C = 0^{s}\cdot0004 \qquad T = 49^{\circ}.$$

Rotation number, 38. *J. McCabe.* 532. (Eight-day chronometer, but wound every day.)

The balance is of the ordinary construction.

After the second trial the arc of vibration and oil were fairly good.

The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−2·46	−2·50	−1·62	...
Second Trial	−4·38	−3·86	−3·61	−2·70

The deduced coefficients are—

$$C = 0^{s}\cdot0015 \qquad T = 63^{\circ}.$$

The residuals and values of R are—

		55°	70°	85°	95°
	s.	s.	s.	s.	s.
First Trial	R, −2·87 *	+0·31	+0·30	+0·52	...
Second Trial	R, −4·23	−0·25	+0·30	−0·11	−0·01

* This number is obviously wrong through an oversight in the computations; $-2^{s}\cdot49$ would represent the rates better.

Rotation number, 39. *J. McCabe.* 538. (Eight-day chronometer, but wound daily.)

The balance is of the ordinary construction.

After the second trial the arc of vibration was found fairly good, the oil rather discoloured.

The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−2·61	−3·72	−3·29	...
Second Trial	−11·22	−10·93	−10·66	−9·48

The deduced coefficients are—

$$C = 0^{s}\cdot0038 \qquad T = 72^{\circ}.$$

The residuals and values of R are—

		55°	70°	85°	95°
	s.	s.	s.	s.	s.
First Trial	R, −3·79	+0·09	+0·06	−0·14	...
Second Trial	R, −11·51	−0·81	+0·57	+0·21	+0·02

Rotation number, 40. *J. McCabe.* 541. (Eight-day chronometer, but wound every day.)

The balance is of the ordinary construction.

After the second trial the arc of vibration was found fairly good, the oil much discoloured.

The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−1·23	−1·50	−1·38	...
Second Trial	−4·76	−5·80	−4·98	−4·08

The deduced coefficients are—

$$C = 0^{s}\cdot0020 \qquad T = 70^{\circ}.$$

The residuals and values of R are—

		55°	70°	85°	95°
	s.	s.	s.	s.	s.
First Trial	R, −1·67	−0·01	+0·17	−0·16	...
Second Trial	R, −5·44	+0·23	−0·36	+0·01	+0·11

Rotation number, 41. *D. Gill & Son.* 1.

No particulars of balance are given; the balance staff was accidentally broken at Mauritius.

The mean rates are—

	55°	70°	85°
	s.	s.	s.
First Trial	−1·80	−2·34	−1·43

The deduced coefficients are—

$$C = 0^{s}\cdot0032 \qquad T = 68^{\circ}.$$

Rotation number, 42. *V. Kullberg.* 488.

The balance is Kullberg's flat-rim balance.

After the second trial the arc of vibration was found somewhat diminished; the oil was somewhat discoloured.

The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	−0·76	−0·52	−0·54	...
Second Trial	+0·12	+0·57	+0·37	−0·07
	+1·33	−0·18	−0·44	...
	...	+1·40	...	...

Assuming that the state of the oil accounts for the irregularity of the rates in the second trial, the chronometer may be said from the first trial, as far as temperature is concerned, to require no correction.

Rotation number, 43. *J. Walker.* 174.

The balance is of the ordinary construction.

After the second trial the arc of vibration was found to be fairly good; the oil was very much discoloured.

The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	0·00	−0·45	+0·43	...
Second Trial	[+5·58]	+1·65	+2·65	+3·47

Rejecting the results for 55° in the second trial, the coefficients are—

$$C = 0^{s}\cdot0032 \qquad T = 68^{\circ}.$$

The residuals and values of R are—

	s.	55°	70°	85°	95°
		s.	s.	s.	s.
First Trial	R, −0·50	−0·04	+0·04	+0·01	...
Second Trial	R, +1·52	...	+0·08	+0·21	−0·33

Rotation number, 44. *W. B. Crisp.* 3072.

The balance is of the ordinary construction.

After the second trial the arc of vibration was good, the oil somewhat discoloured.

The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	+2·35	+0·93	+0·92	...
Second Trial	−0·57	−2·63	−2·33	−1·60

The deduced coefficients are—

$$C = 0^{s}\cdot0032 \qquad T = 77^{\circ}.$$

The residuals and values of R are—

	s.	55°	70°	85°	95°
		s.	s.	s.	s.
First Trial	R, +0·77	+0·04	0·00	−0·05	...
Second Trial	R, −2·51	+0·40	−0·28	−0·02	−0·13

Rotation number, 45. *W. B. Crisp.* 3106.

The balance is of the ordinary construction.

After the second trial the arc of vibration and the oil were good.

The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	+4·66	+3·04	+3·45	...
Second Trial	[+0·35]	−1·96	−1·47	−0·53

Rejecting the results for 55° in the second trial, the coefficients are—

$$C = 0^{s}\cdot0045 \qquad T = 74^{\circ}.$$

The residuals and values of R are—

	s.	55°	70°	85°	95°
		s.	s.	s.	s.
First Trial	R, +2·97	+0·07	0·00	−0·06	...
Second Trial	R, −2·19	...	+0·16	+0·18	−0·32

Rotation number, 46. *W. B. Crisp*

No particulars whatever given of this chronometer.

Rotation number, 47. *W. B. Crisp.* 3197.

The balance is of the ordinary construction.
After the second trial the arc of vibration was found good; the oil was discoloured.
The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	+12·65	+12·69	+14·08	...
Second Trial	+8·19	+8·93	+11·35	+13·48

The deduced coefficients are—

C=0ˢ·0033 T=57°.

The residuals and values of R are—

	s.	55°	70°	85°	95°
		s.	s.	s.	s.
First Trial	R, +12·11	+0·53	+0·02	−0·62	...
Second Trial	R, +8·54	−0·36	−0·17	+0·22	+0·17

Rotation number, 48. *W. B. Crisp.* 3262.

The balance is of the ordinary construction.
After the second trial the arc of vibration was fairly good; the oil was discoloured.
The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	+7·08	+6·34	+8·09	...
Second Trial	[−0·49]	−2·18	−0·34	+2·92

Rejecting the results for 55° in the second trial, the coefficients are—

C=0ˢ·0055 T=65°.

The residuals and values of R are—

	s.	55°	70°	85°	95°
		s.	s.	s.	s.
First Trial	R, +6·19	+0·34	+0·01	−0·30	...
Second Trial	R, −2·26	...	−0·04	−0·28	+0·23

Rotation number, 49. *W. B. Crisp.* 3263.

The balance is of the ordinary construction.
After the second trial the arc of vibration was fairly good; the oil was discoloured.
The mean rates are—

	55°	70°	85°	95°
	s.	s.	s.	s.
First Trial	+0·68	−0·31	+0·10	...
Second Trial	−5·12	−6·02	−5·07	−4·08

The deduced coefficients are—

C=0ˢ·0030 T=72°.

The residuals and values of R are—

	s.	55° s.	70° s.	85° s.	95° s.
First Trial	R, −0·30	+0·12	−0·02	−0·10	...
Second Trial	R, −5·83	−0·15	−0·20	+0·25	+0·16

Rotation number, 50. *Parkinson & Frodsham.* 4091.

The balance is of the ordinary construction.

After the second trial the arc of vibration and the oil were good.

The mean rates are—

	55° s.	70° s.	85° s.	95° s.
First Trial	−1·77	−1·84	−1·02	...
Second Trial	[−2·16]	−3·66	−2·58	−1·63

The deduced coefficients, rejecting the results for 55° in the second trial, are—

C = 0ˢ·0025 T = 65°.

The residuals and values of R are—

	s.	55° s.	70° s.	85° s.	95° s.
First Trial	R, −1·99	−0·03	+0·09	−0·03	...
Second Trial	R, −3·64	...	−0·08	+0·06	−0·24

Rotation number, 51. *J. Walker.* 103.

The balance is of the ordinary construction.

After the second trial the arc of vibration was found fairly good; the oil was much discoloured.

The mean rates are—

	55° s.	70° s.	85° s.	95° s.
First Trial	+0·58	+0·25	+0·93	...
Second Trial	[+0·36]	−1·08	−0·07	+0·90

The deduced coefficients are, rejecting the results of 55° in the second trial—

C = 0ˢ·0035 T = 70°.

The residuals and values of R are—

	s.	55° s.	70° s.	85° s.	95° s.
First Trial	R, +0·07	−0·28	+0·18	+0·07	...
Second Trial	R, −1·08	...	0·00	+0·22	−0·21

Rotation number, 52.

No particulars whatever of this chronometer.

CHAPTER II.

DETERMINATION OF THE LONGITUDE OF MAURITIUS BY THE TRANSPORT OF CHRONOMETERS—OUTWARD JOURNEY.

We now proceed to give in detail all the operations on the journey from Greenwich to Mauritius, referring the reader to the Introduction for particulars regarding the choice of stations, &c.

The chronometers were not carried in their original boxes, but in six large padded boxes lined with silk, each capable of containing nine chronometers. These boxes were hung in gimbals on the plan used for chronometers. Each instrument was lifted out of its special recess to be wound. Chronometer 50 was compared with all the others generally every morning. These comparisons, as derived from the original note-books, are given in the following table, in which the number of seconds recorded is the mean of two comparisons, and shows the reading of the compared chronometer when (50) stood at $0^{s}\cdot0$. The Roman numerals indicate the several large boxes. The approximate time by (50) for each box is given at the foot of the page. To find the actual time shown by each chronometer at the moment of any comparison, apply the minutes given in the third column and the tabulated seconds to the time by chronometer 50. Thus for chronometer 1 on June 18, 1874, first comparison, the time by (50) was $1^{h}\ 0^{m}\ 0\cdot00$; and the time by chronometer 1, $1^{h}\ 7^{m}\ 10^{s}\cdot20$.

Between July 4 and July 6 chronometer 50 'tripped' for rather more than one minute, hence the change of minutes and the sudden jump in the comparisons between those dates.

COMPARISON OF CHRONOMETERS—OUTWARD JOURNEY.

	Rotation No.	Correction to (50)	SECONDS OF COMPARED CHRONOMETER											
			June 18	June 18	June 19	June 20	June 21	June 22	June 23	June 24	June 25	June 26	June 27	June 28
		h. m.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
I.	1	+ 0 7	10·2	8·65	...	6·65	6·35	6·3	6·2	6·0	5·7	5·15	5·3	5·3
	2	+ 0 10	4·0	4·45	...	6·1	7·6	9·8	12·0	14·3	16·7	18·5	21·25	24·35
	3	+ 0 9	42·4	42·55	...	43·6	44·55	45·7	46·75	48·0	48·8	49·5	50·5	51·8
	4	+ 0 9	25·3	25·45	...	26·5	27·6	28·7	29·65	30·5	31·25	31·7	32·45	33·35
	7	+ 0 9	47·5	48·7	...	51·95	54·5	56·75	59·85	62·7	65·3	67·5	70·6	73·5
	8	+ 0 6	27·0	26·2	...	25·0	25·0	25·2	25·65	26·0	26·5	26·5	26·75	27·9
	9	+ 0 7	9·3	8·9	...	8·45	8·85	9·6	10·35	10·8	11·35	11·65	12·0	12·8
	10	+ 0 9	27·1	27·3	...	28·2	29·5	30·85	32·0	33·3	34·5	35·4	37·0	39·25
	11	+ 0 10	30·8	31·6	...	34·6	36·7	39·2	41·8	45·0	48·5	50·95	55·2	59·0
II.	12	+ 0 3	74·8	72·8	...	69·0	67·5	66·3	65·0	63·45	61·6	59·65	57·7	56·0
	13	+ 0 3	34·6	32·2	...	27·7	25·9	25·0	24·35	23·75	22·7	21·7	20·9	20·35
	14	+ 0 6	30·0	28·7	...	26·45	26·0	26·45	26·3	26·7	27·0	27·0	27·7	28·5
	15	+ 0 3	5·0	5·65	...	6·7	8·0	9·65	11·5	13·25	14·75	15·85	17·35	19·85
	16	+ 0 5	52·9	52·45	...	51·7	51·45	52·0	52·0	52·1	51·8	51·5	51·75	51·9
	17	+ 0 11	14·5	15·55	...	18·75	20·3	23·1	25·5	27·7	30·0	31·85	34·5	37·05
	18	+ 0 12	55·2	57·45	...	64·3	68·1	72·5	76·3	80·0	83·3	86·25	90·35	94·3
	19	+ 0 5	28·7	25·6	...	20·2	18·0	15·8	13·75	11·55	9·5	7·3	4·65	3·0
	20	+ 0 9	19·8	19·9	...	20·6	21·3	21·85	23·5	25·0	26·25	27·45	29·3	31·4
III.	21	+ 0 7	18·6	16·8	...	14·2	13·5	12·5	11·7	10·75	9·8	8·7	7·05	6·7
	22	+ 0 10	10·3	11·75	...	14·85	16·45	18·5	20·45	21·5	22·65	23·6	24·95	26·0
	23	+ 0 8	23·4	23·75	...	25·9	25·7	26·7	28·75	29·5	30·5	30·7	31·05	32·3
	24	+ 0 8	21·3	21·6	...	23·95	25·5	27·35	29·3	31·0	32·45	33·5	34·7	36·5
	25	+ 0 4	61·1	59·2	...	54·8	53·25	52·65	52·3	52·0	51·45	50·5	50·55	51·35
	26	− 0 2	78·6	74·9	...	65·8	61·45	57·15	53·3	48·75	44·75	40·4	35·5	31·5
	27	0 0	78·6	75·0	...	67·25	64·0	60·5	56·4	52·45	48·0	43·8	39·0	34·05
	28	+ 0 6	19·0	19·35	...	18·6	18·3	18·5	18·9	18·5	18·15	17·5	17·0	17·0
	29	+ 0 2	85·0	82·5	...	76·9	74·35	72·15	69·9	67·0	64·0	61·0	57·7	54·5
IV.	30	+ 0 16	49·05	53·3	...	62·25	67·3	72·45	76·95	81·7	87·0	96·5	96·75	102·2
	31	− 0 1	71·05	66·8	...	58·0	53·8	49·8	45·8	41·6	37·0	33·0	28·25	24·3
	32	+ 0 7	25·5	25·65	...	28·2	30·1	32·45	34·4	36·3	37·5	38·3	40·0	41·5
	33	+ 0 3	73·7	71·35	...	65·45	62·7	61·0	58·8	56·5	53·95	51·0	48·7	46·25
	34	+ 0 3	76·8	74·0	...	68·0	65·55	63·6	61·45	59·6	57·3	55·0	52·4	50·7
	35	+ 0 5	61·8	60·1	...	56·0	54·8	53·7	53·5	53·0	51·8	50·5	49·3	49·2
	36	+ 0 5	47·4	46·25	...	43·65	42·9	42·75	42·6	42·9	42·85	42·5	43·0	44·25
	37	+ 0 4	42·3	40·9	...	37·6	36·6	36·0	35·3	34·65	33·8	33·0	32·5	32·3
	38	+ 0 16	44·25	44·65	...	45·6	46·85	48·3	48·95	49·75	51·25	52·0	52·65	54·25
V.	39	+ 0 14	49·8	52·0	...	58·7	62·7	65·6	68·3	71·6	74·25	77·5	80·3	84·35
	40	+ 0 7	27·8	27·75	...	28·0	27·85	28·25	28·55	29·05	29·0	29·0	29·3	29·95
	42	+ 0 5	22·95	21·2	...	18·0	16·25	14·65	13·0	11·5	10·0	8·4	6·5	5·35
VI.	44	+ 0 1	69·5	66·8	...	62·1	60·0	58·25	56·9	55·35	53·5	51·2	49·5	48·75
	45	− 0 2	89·65	84·6	...	74·5	69·75	66·0	61·9	58·2	53·75	49·5	45·2	41·3
	46	+ 0 6	56·5	59·6	...	65·5	68·6	72·05	75·2	78·0	81·35	83·85	86·75	90·2
	47	− 0 15	194·15	181·4	...	155·2	142·9	130·5	118·0	105·55	92·55	79·85	66 5	53·45
	48	− 0 6	97·5	90·05	...	76·05	69·1	60·95	52·9	45·5	39·0	32·75	25·25	18·25
	49	+ 0 3	53·6	53·6	...	53·75	53·45	54·35	55·4	55·75	56·0	55·5	56·0	56·75
	51	+ 0 3	42·6	40·15	...	33·95	31·9	29·95	28·2	26·5	24·3	22·25	19·8	18·0
	52	− 0 12	34·9	32·6	...	27·7	25·85	24·5	23·2	22·0	20·15	18·4	16 5	15 55
			h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
I.	. . .		1 0	21 53	...	22 2	22 5	22 23	21 39	21 4	21 58	19 10	20 15	20 5
II.	. . .		1 4	22 5	...	22 18	22 22	22 38	21 52	21 16	21 14	19 11	20 15	20 23
III.	. . .		1 7	22 50	...	22 38	22 34	22 56	22 6	21 32	21 27	19 32	20 35	20 38
IV.	. . .		1 10	23 25	...	23 4	22 56	23 15	22 19	21 54	21 49	19 40	20 52	21 2
V.	. . .		1 13	23 44	...	23 13	23 4	23 41	22 26	22 0	21 56	19 42	20 52	21 16
VI.	. . .		1 23	24 25	...	24 17	23 34	23 43	22 45	22 17	22 13	20 15	21 25	...

COMPARISON OF CHRONOMETERS—OUTWARD JOURNEY—*continued.*

	Rotation No.	Correction to (50)	SECONDS OF COMPARED CHRONOMETER												
			June 29	June 30	July 1	July 2	July 3	July 4	Correction to (50)	July 6	July 6	July 7	July 9	July 9	July 10
		h. m.	s.	s.	s.	s.	s.	s.	h. m.	s.	s.	s.	s.	s.	s.
I.	1	+ 0 7	5·5	5·7	7·0	7·5	8·5	9·25	+ 0 6	10·45	10·4	12·7	16·5	18·25	20·2
	2	+ 0 10	26·8	29·8	34·25	37·8	41·1	44·75	+ 0 9	46·5	52·0	57·45	64·35	68·2	73·0
	3	+ 0 9	52·75	54·5	56·45	58·35	60·55	63·1	+ 0 8	65·5	68·35	73·0	78·5	81·95	85·8
	4	+ 0 9	34·5	35·5	37·5	38·9	40·5	41·75	+ 0 8	42·45	43·9	46·9	50·5	52·7	55·25
	7	+ 0 10	16 1	18·8	23·0	26·35	29·75	33·5	+ 0 9	36·7	42·9	49·3	55·9	60·0	64·55
	8	+ 0 6	29·0	30·0	31·5	32·75	34·0	35·2	+ 0 5	36·5	38·3	41·5	45·75	48·0	50·6
	9	+ 0 7	13·5	14·3	16·0	17·4	18·5	19·8	+ 0 6	20·45	21·95	25·05	28·75	30·8	33·5
	10	+ 0 9	41·4	43·5	46·75	49·8	52·8	56·0	+ 0 8	56·8	61·9	66·25	71·7	75·5	78·75
	11	+ 0 11	3·1	6·3	10·75	15·1	18·7	22·2	+ 0 10	25·2	31·25	37·5	45·4	49·8	54·9
II.	12	+ 0 3	54·5	53·4	52·5	51·45	50·35	49·5	+ 0 2	45·55	46·75	47·0	47·45	47·85	48·0
	13	+ 0 3	19·8	19·5	19·3	18·3	17·75	17·0	+ 0 2	13·7	15·25	16·2	17·2	17·25	17·5
	14	+ 0 6	29·05	29·5	30·5	30·7	31·0	30·95	+ 0 5	28·25	30·5	32·3	33·45	34·0	34·75
	15	+ 0 3	21·9	24·1	27·35	29·5	31·5	33·3	+ 0 2	32·8	36·95	41·7	47·45	50·5	54·2
	16	+ 0 5	51·7	51·5	52·3	52·35	52·4	52·5	+ 0 4	49·5	52·2	54·0	56·5	57·5	58·8
	17	+ 0 11	39·8	42·2	45·8	48·5	51·5	54·3	+ 0 10	55·4	60·45	64·85	71·25	74·5	78·75
	18	+ 0 13	38·3	41·8	47·0	51·35	55·75	59·9	+ 0 12	63·5	70·05	76·75	85·2	89·8	95·35
	19	+ 0 4	60·8	59·5	58·2	56·8	55·45	54·2	+ 0 3	49·9	51·7	52·5	53·45	53·75	54·0
	20	+ 0 9	33·75	35·8	38·9	41·5	44·5	47·25	+ 0 8	48·6	53·5	58·0	64·2	67·5	72·0
III.	21	+ 0 7	6·15	5·7	6·0	5·5	5·5	5·5	+ 0 6	2·75	5·5	7·25	9·85	11·3	13·05
	22	+ 0 10	27·0	28·0	29·35	30·6	30·75	31·5	+ 0 9	29·3	31·95	34·1	35·75	36·85	38·0
	23	+ 0 8	32·5	33·0	32·95	32·7	32·5	32·75	+ 0 7	30·25	32·0	33·5	35·7	36·5	36·8
	24	+ 0 8	37·9	39·2	40·5	41·75	41·45	40·75	+ 0 7	36·7	37·5	37·7	37·75	37·4	37·0
	25	+ 0 4	51·8	52·5	54·25	55·5	56·75	58·8	+ 0 3	58·2	62·0	65·5	69·5	71·6	74·3
	26	− 0 3	86·85	83·5	79·0	75·0	71·5	67·7	− 0 4	59·5	58·5	56·0	52·3	51·0	47·8
	27	− 0 1	88·65	84·0	78·5	72·45	66·0	58·4	− 0 2	46·0	41·5	35·0	27·15	22·0	16·0
	28	+ 0 6	16·5	16·7	16·55	16·45	16·35	15·5	+ 0 5	13·0	14·8	15·8	17·1	18·0	18·8
	29	+ 0 2	51·25	48·5	45·5	42·4	39·8	36·35	+ 0 1	30·0	30·0	28·75	26·5	25·15	22·9
IV.	30	+ 0 17	47·4	52·2	58·75	64·5	70·25	76·0	+ 0 16	80·45	88·5	96·0	100·0	111·8	119·45
	31	− 0 2	79·95	76·5	72·5	68·5	64 7	61·15	− 0 1	53·45	52·45	50·1	47·0	45·3	43·0
	32	+ 0 7	43·45	45·0	46·35	47·8	49·35	50·35	+ 0 6	50·2	55·0	59·05	63·8	65·85	68·75
	33	+ 0 3	44·1	42·8	40·8	38·95	37·75	35·95	+ 0 2	31·45	32·7	33·15	33·2	33·0	32·65
	34	+ 0 3	48·5	47·0	45·75	43·95	43·0	41·6	+ 0 2	37·5	38·7	39·0	39·05	39·0	38·8
	35	+ 0 5	48·5	48·3	48·5	47·95	47·7	48·2	+ 0 4	46·0	48·0	49·5	51·8	53·15	54·8
	36	+ 0 5	45·1	46·5	48·25	49·8	51·75	54·2	+ 0 4	54·0	58·3	62·15	67·0	69·8	73·05
	37	+ 0 4	32·1	32·2	32·45	32·7	33·0	33·4	+ 0 3	30·85	33·4	35·45	37·85	39·0	40·5
	38	+ 0 16	55·2	56·5	58·3	60·2	61·3	63·25	+ 0 15	63·2	68·0	71·95	76·5	79·0	81·6
V.	39	+ 0 15	27·95	30·0	34·8	38·25	40·5	...	+ 0 14	45·95	53·4	60·45	68·95	74·0	78·25
	40	+ 0 7	30·5	31·2	32·75	33·15	34·3	35·3	+ 0 6	34·0	37·45	40·0	43·4	45·1	46·8
	42	+ 0 4	64·1	63·2	62·75	62·0	61·0	60·5	+ 0 3	57·5	60·0	61·9	64·0	65·2	65·7
VI.	44	+ 0 1	47·75	47·1	46·35	45·5	45·5	45·2	0 0	40·75	42·5	43·5	44·8	45·45	46·25
	45	− 0 2	37·0	33·5	29·45	25·5	21·75	18·05	− 0 3	10·95	10·25	8·5	6·3	4·5	2·2
	46	+ 0 7	33·7	37·0	40·95	44·8	48·5	52·25	+ 0 6	53·75	59·5	64·7	71·2	75·0	79·8
	47	− 0 17	160·05	147·9	133·5	119·9	107·6	94·85	− 0 18	75·3	66·0	54·5	39·8	30·45	18·8
	48	− 0 7	70·5	63·3	55·0	47·0	40·0	32·5	− 0 8	23·0	21·15	17·4	11·25	7·45	2·5
	49	+ 0 3	57·5	58·2	60·0	61·25	63·5	64·75	+ 0 2	63·6	67·7	71·3	75·1	77·35	80·4
	51	+ 0 3	16·45	15·7	14·5	12·95	11·8	10·0	+ 0 2	6·25	5·8	4·3	4·1	3·9	2·85
	52	− 0 12	13·9	12·8	11·0	9·8	...	7·35	− 0 13	2·25	4·0	4·6	5·2	5·5	5·5
			h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
I.			20 52	16 49	19 55	20 5	19 25	18 8		0 5	20 5	19 38	2 0	19 55	19 0
II.			20 30	17 12	20 5	20 27	19 30	18 20		0 30	20 24	19 56	2 10	20 4	19 10
III.			20 5	17 30	20 15	20 30	19 40	19 1		0 30	20 45	20 11	2 22	20 18	19 25
IV.			20 59	18 15	20 55	21 0	20 1	19 16		0 33	21 20	20 40	2 35	20 38	19 37
V.			20 59	18 23	20 55	21 0	20 5	19 24		0 40	21 20	20 40	2 43	20 45	19 43
VI.			21 0	19 6	21 6	21 10	20 13	19 42		1 0	21 51	21 2	2 51	20 56	19 52

COMPARISON OF CHRONOMETERS—OUTWARD JOURNEY—*continued.*

	Rotation No.	Correction to (50)	SECONDS OF COMPARED CHRONOMETER											
			July 11	July 12	July 13	July 14	July 17	July 18	July 19	July 20	July 20	July 21	July 22	July 24
		h. m.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
I.	1	+ 0 6	22·45	24·6	26·9	28·8	34·2	36·5	39·0	41·2	43·5	...	...	...
	2	+ 0 10	18·15	23·5	29·2	34·55	45·75	50·75	56·05	60·85	66·3	...	...	...
	3	+ 0 9	30·3	35·2	40·2	44·65	54·0	58·2	62·5	66·7	71·05	...	...	...
	4	+ 0 8	57·95	60·8	64·0	66·5	71·75	74·5	77·1	79·55	81·8	...	...	...
	7	+ 0 10	9·35	14·3	19·2	23·85	34·15	38·2	43·2	47·7	52·5	...	...	...
	8	+ 0 5	53·5	56·4	59·8	62·85	70·45	73·8	77·5	80·1	83·05	...	...	...
	9	+ 0 6	36·25	39·1	42·3	45·0	51·5	56·15	56·95	60·0	62·9	...	...	...
	10	+ 0 9	23·0	27·4	32·85	37·5	46·0	50·2	54·8	58·5	62·55	...	...	...
	11	+ 0 11	0·4	6·5	13·0	19·5	32·9	38·6	45·5	51·75	59·0	...	...	...
II.	12	+ 0 2	48·4	48·8	49·45	49·5	50·0	50·8	51·5	52·0	52·75	...	...	...
	13	+ 0 2	18·0	18·0	18·2	17·65	16·9	17·5	18·0	18·3	19·0	...	...	...
	14	+ 0 5	35·85	36·5	37·0	36·8	36·75	36·9	37·5	37·1	37·5	...	...	...
	15	+ 0 2	58·05	61·4	66·25	69·6	77·2	78·5	79·85	81·15	81·3	...	...	...
	16	+ 0 5	0·0	1·7	3·5	4·75	7·8	8·8	10·05	11·15	12·0	...	...	...
	17	+ 0 11	23·25	28·0	32·6	36·95	47·0	51·5	56·2	60·7	65·2	...	...	...
	18	+ 0 13	41·45	47·5	53·8	59·8	73·3	79·3	85·8	92·2	98·2	...	...	...
	19	+ 0 3	54·0	54·7	55·55	56·2	57·7	58·8	59·5	60·5	61·5	...	...	...
	20	+ 0 9	17·4	22·7	28·15	33·2	44·15	48·0	52·0	55·7	60·0	...	...	...
III.	21	+ 0 6	14·95	16·6	18·5	19·95	24·0	25·95	27·9	30·0	31·95	...	...	...
	22	+ 0 9	39·7	41·0	41·7	42·0	44·2	45·0	45·0	45·5	46·0	...	...	...
	23	+ 0 7	37·9	38·5	38·9	39·45	40·2	41·75	42·7	44·15	45·5	...	...	...
	24	+ 0 7	36·25	34·2	29·85	24·8	19·0	17·1	15·0	13·5	12·0	...	...	...
	25	+ 0 4	17·5	21·0	25·0	28·75	36·1	38·95	41·95	45·0	48·1	...	...	...
	26	− 0 4	45·15	42·5	39·5	36·3	28·85	26·15	22·5	19·0	15·5	...	...	...
	27	− 0 4	129·2	121·0	110·4	99·35	79·9	71·5	61·2	52·0	43·0	...	...	...
	28	+ 0 5	19·6	20·5	21·55	21·9	23·0	22·25	21·2	20·5	19·55	...	...	...
	29	+ 0 1	21·0	19·1	17·5	15·85	11·65	10·75	9·0	7·45	6·5	...	...	...
IV.	30	+ 0 18	7·5	15·4	23·45	31·45	48·2	56·0	64·2	72·05	79·85	...	...	...
	31	− 0 3	40·4	37·9	35·4	32·45	25·55	23·0	20·0	17·4	14·6	...	...	...
	32	+ 0 7	12·2	16·2	19·8	22·8	32·5	36·95	41·4	45·5	49·35	...	...	...
	33	+ 0 2	32·6	32·75	32·8	32·5	33·0	33·65	34·1	34·6	34·75	...	...	...
	34	+ 0 2	39·0	39·5	40·3	41·0	41·5	42·25	42·8	43·5	44·0	...	...	...
	35	+ 0 4	56·5	58·5	60·0	61·5	63·4	64·6	65·55	66·55	67·7	...	...	...
	36	+ 0 5	17·0	21·5	26·05	30·25	38·7	42·5	46·5	50·25	54·0	58·0	61·05	64·9
	37	+ 0 3	42·2	44·2	47·0	49·5	54·2	56·5	58·5	60·5	62·45	65·0	66·5	67·5
	38	+ 0 16	24·45	27·5	30·75	33·9	42·55	45·85	49·2	52·2	55·75	...	...	...
V.	39	+ 0 15	23·95	30·0	35·65	41·7	56·05	63·3	71·5	79·25	86·75	...	...	...
	40	+ 0 6	49·5	52·2	54·8	57·2	62·75	64·9	67·5	69·9	72·2	...	...	...
	42	+ 0 4	7·0	8·5	10·5	12·3	15·0	16·5	18·1	19·5	21·75	...	25·0	25·5
VI.	44	+ 0 2	47·2	48·5	50·0	51·0	52·7	54·0	55·45	56·4	57·5	...	...	...
	45	− 0 4	59·8	57·5	55·2	52·55	48·0	46·35	44·2	42·2	40·5	...	...	...
	46	+ 0 7	25·0	30·5	35·7	40·5	52·2	56·5	62·3	67·45	72·6	...	...	...
	47	− 0 20	126·5	114·4	101·9	88·7	60·05	48·75	36·05	24·0	12·5	...	...	...
	48	− 0 10	116·5	110·4	103·55	95·5	81·05	75·55	69·5	62·8	57·5	...	...	...
	49	+ 0 3	24·0	28·0	31·0	34·0	41·6	45·2	48·8	52·1	55·4	...	...	...
	51	+ 0 1	61·8	61·5	61·2	60·5	58·35	58·0	57·0	56·5	55·75	...	...	...
	52	− 0 13	5·9	6·0	5·75	5·15	4·75	5·5	5·2	4·7	4·4	...	...	...
			h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
I.			19 0	18 50	19 0	18 50	2 35	0 38	1 53	0 24	24 20	...	...	...
II.			19 10	19 10	19 10	19 20	2 11	...	1 6	...	24 29	...	...	...
III.			19 25	19 36	19 25	19 37	3 3	1 7	1 20	0 55	24 35	...	...	...
IV.			19 42	20 1	19 40	19 51	3 18	1 22	1 35	1 10	23 23	...	...	...
V.			19 48	20 7	19 45	20 0	3 30	1 30	1 44	1 16	23 50	...	...	...
VI.			20 3	20 25	20 7	20 9	3 40	1 20	1 59	1 31	24 12	...	...	...

COMPARISON OF CHRONOMETERS—OUTWARD JOURNEY—*continued.*

	Rotation No.	Correction to (50)	Seconds of Compared Chronometer											
			July 25	July 25	July 26	July 27	July 28	July 29	July 30	July 31	Aug. 2	Aug. 3	Aug. 4	Aug. 6
		h. m.		s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
I.	1	+ 0 6	...	53·0	54·75	56·2	58·0	59·5	61·0	61·85	63·5	64·6	66·05	67·6
	2	+ 0 11	...	25·75	28·85	32·25	36·0	39·25	42·0	44·8	47·6	50·0	53·05	58·9
	3	+ 0 10	...	28·45	32·0	35·8	39·2	42·25	45·0	47·5	50·0	52·4	54·9	59·8
	4	+ 0 9	...	32·2	34·2	36·35	38·5	40·6	42·5	44·0	46·0	47·55	49·4	52·6
	7	+ 0 11	...	12·75	16·8	21·0	25·0	28·85	32·35	35·6	39·35	42·8	46·1	51·75
	8	+ 0 6	...	34·65	37·05	39·1	41·3	43·5	45·2	47·0	49·25	51·1	53·0	56·25
	9	+ 0 7	...	15·8	18·3	20·8	23·3	25·75	28·0	30·2	32·6	34·95	37·05	40·7
	10	+ 0 10	...	17·75	21·1	24·6	27·85	30·5	33·1	35·5	37·9	40·1	42·1	46·2
	11	+ 0 12	...	31·2	37·4	43·3	49·4	55·2	60·8	66·0	71·5	76·5	81·75	90·8
II.	12	+ 0 2	...	55·9	55·8	56·2	56·55	56·8	56·8	56·5	56·5	56·25	56·25	55·8
	13	+ 0 2	...	19·5	19·8	20·2	20·7	20·75	20·55	20·5	20·45	20·0	19·5	18·5
	14	+ 0 5	...	35·05	34·05	33·2	32·4	31·5	30·5	29·45	28·45	27·4	26·35	25·65
	15	+ 0 3	...	22·0	20·65	20·5	20·5	18·5	16·6	14·4	12·2	9·05	6·15	2·2
	16	+ 0 5	...	16·05	16·75	17·5	18·35	18·0	17·2	16·75	16·4	15·5	14·7	14·0
	17	+ 0 12	...	26·5	30·55	34·45	38·8	42·5	46·0	49·2	52·7	56·0	59·5	65·55
	18	+ 0 15	...	7·05	12·5	18·0	23·8	28·8	33·5	38·5	43·5	48·5	53·9	61·75
	19	+ 0 3	...	62·8	63·0	63·2	63·5	63·35	62·7	62·2	61·7	61·0	60·3	58·7
	20	+ 0 10	...	17·1	20·7	24·55	28·35	31·8	35·0	38·2	41·55	44·5	47·7	53·5
III.	21	+ 0 6	...	40·7	42·3	44·0	45·55	47·0	47·85	49·0	50·3	51·2	52·35	54·0
	22	+ 0 9	...	46·5	46·05	45·7	45·5	45·35	44·85	44·4	44·5	44·55	44·5	44·6
	23	+ 0 7	...	49·5	50·0	50·5	51·1	52·0	52·5	53·35	54·2	55·0	56·05	57·7
	24	+ 0 7	...	8·7	8·05	7·0	6·0	6·0	6·0	6·5	7·5	8·6	10·2	8·0
	25	+ 0 5	...	0·55	3·1	6·0	8·5	10·7	12·7	14·25	16·05	17·5	18·8	20·6
	26	− 0 5	...	56·0	52·0	48·1	44·45	40·3	36·2	32·1	28·0	24·0	19·8	12·5
	27	− 0 6	...	119·5	110·5	101·0	93·0	85·2	77·95	71·5	65·1	59·7	56·0	44·5
	28	+ 0 5	...	14·0	13·2	12·5	12·0	11·0	10·0	9·05	7·75	6·45	4·85	2·55
	29	0 0	...	60·5	59·0	57·5	56·2	54·8	53·25	52·0	50·8	49·6	48·5	46·2
IV.	30	+ 0 19	...	59·75	67·95	76·1	84·5	92·85	100·7	108·45	116·4	124·1	132·0	144·55
	31	− 0 4	...	60·0	56·8	53·55	50·5	47·55	44·5	41·5	38·5	35·65	32·8	28·0
	32	+ 0 8	...	11·05	14·5	18·45	22·5	26·5	29·75	33·05	36·6	40·15	43·45	49·25
	33	+ 0 2	...	36·65	36·95	37·1	37·75	38·25	38·5	39·0	39·5	39·9	40·25	40·55
	34	+ 0 2	...	42·55	42·0	41·55	40·75	39·7	38·5	37·0	35·7	34·6	33·5	30·8
	35	+ 0 5	...	11·25	12·0	12·55	13·1	13·5	13·5	13·5	13·5	13·05	12·75	12·0
	36	+ 0 6	7·0	10·25	13·5	16·95	19·95	22·85	25·3	27·2	29·25	31·0	32·3	34·5
	37	+ 0 4	9·5	11·3	13·0	14·6	16·3	17·5	18·5	19·5	20·4	21·2	21·9	22·45
	38	+ 0 17	...	14·5	18·2	21·75	25·5	28·85	32·15	35·7	39·25	42·75	46·0	51·0
V.	39	+ 0 17	...	4·4	11·75	19·2	26·95	33·8	41·3	48·15	56·1	64·0	71·5	83·0
	40	+ 0 7	...	23·1	25·2	27·5	29·9	32·0	34·0	35·9	38·05	40·0	41·55	44·2
	42	+ 0 4	26·7	28·0	29·1	30·4	31·4	32·0	32·5	32·9	33·15	33·4	33·1	32·5
VI.	44	0 0	...	59·5	59·8	60·0	60·45	60·4	60·0	59·5	59·0	58·5	57·4	57·0
	45	− 0 4	...	30·65	28·5	26·35	24·4	22·0	20·0	18·0	16·0	14·0	11·65	7·75
	46	+ 0 8	...	38·0	43·0	48·25	53·5	59·0	64·2	69·5	74·95	80·6	86·2	95·55
	47	− 0 24	...	191·1	178·8	166·5	154·15	141·7	129·05	116·85	104·2	92·0	79·0	56·8
	48	− 0 11	...	95·0	90·5	86·0	81·5	76·95	71·0	65·85	59·95	54·5	49·25	35·75
	49	+ 0 4	...	11·95	15·5	18·75	22·1	25·75	28·8	31·8	35·0	38·1	41·5	48·0
	51	+ 0 1	...	49·5	48·0	47·2	46·0	44·8	43·05	41·8	40·5	39·0	37·5	35·5
	52	− 0 14	...	63·6	63.0	62·8	62·1	61·25	60·5	59·5	58·5	57·5	56·0	53·05
			h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
I.			...	...	23 26	23 8	23 8	23 37	23 38	23 21	0 6	0 22	1 15	8 13
II.			...	...	23 35	23 15	23 15	23 42	23 43	23 26	0 12	0 29	1 25	8 24
III.			...	...	23 43	23 25	23 20	23 48	23 50	23 32	0 17	0 35	1 31	8 49
IV.			...	...	23 51	23 30	23 29	23 55	23 55	23 40	0 22	0 40	1 37	8 58
V.			...	23 55	23 55	23 34	23 32	23 59	23 58	23 43	0 25	0 45	1 52	9 4
VI.			...	...	24 5	23 50	23 40	24 6	24 4	23 51	0 33	0 51	1 52	9 15

Operations at Greenwich.

Comparisons of Chronometers with the Greenwich Mean-time Clock.

Rotation No.	1874, June 15		1874, June 16		1874, June 17	
	Time by Greenwich clock	Time by compared chronometer	Time by Greenwich clock	Time by compared chronometer	Time by Greenwich clock	Time by compared chronometer
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	8 43 15·35	8 46 0	1 27 14·4	1 30 0	0 4 13·8	0 7 0
2	8 43 27·3	8 49 0	1 27 25·3	1 33 0	0 3 22·3	0 9 0
3	8 43 48·7	8 49 0	1 27 46·9	1 33 0	0 3 44·2	0 9 0
4	8 44 4·9	8 49 0	1 28 3·2	1 33 0	0 4 0·7	0 9 0
7	8 43 45·2	8 49 0	1 28 42·6	1 34 0	0 3 40·0	0 9 0
8	8 44 1·2	8 46 0	1 28 59·9	1 31 0	0 3 58·4	0 6 0
9	8 44 20·3	8 47 0	1 29 18·9	1 32 0	0 4 16·75	0 7 0
10	8 44 3·25	8 49 0	1 29 1·5	1 34 0	0 3 58·8	0 9 0
11	8 45 1·3	8 51 0	1 28 59·05	1 35 0	0 4 55·7	0 11 0
12	8 41 8·7	8 41 0	1 25 8·3	1 25 0	0 3 8·7	0 3 0
13	8 41 48·6	8 41 0	1 25 48·5	1 25 0	0 2 48·65	0 2 0
14	8 41 55·2	8 44 0	1 25 54·35	1 28 0	0 2 53·8	0 5 0
15	8 41 24·4	8 40 0	1 25 22·8	1 24 0	0 3 20·9	0 2 0
16	8 41 33·4	8 43 0	1 25 32·7	1 27 0	0 3 31·75	0 5 0
17	8 42 18·6	8 49 0	1 26 15·9	1 33 0	0 3 12·3	0 10 0
18	8 42 40·6	8 51 0	1 26 37·4	1 35 0	0 3 33·25	0 12 0
19	8 42 55·05	8 44 0	1 26 55·0	1 28 0	0 3 54·8	0 5 0
20	8 43 10·15	8 48 0	1 27 8·25	1 32 0	0 4 5·8	0 9 0
21	8 51 8·45	8 54 0	1 34 7·4	1 37 0	0 6 6·2	0 9 0
22	8 51 24·2	8 57 0	1 34 20·8	1 40 0	0 6 17·2	0 12 0
23	8 52 9·0	8 56 0	1 35 6·8	1 39 0	0 6 3·8	0 10 0
24	8 52 9·95	8 56* 0	1 35 7·9	1 39 0	0 7 5·3	0 11 0
25	8 52 21·45	8 53 0	1 35 21·4	1 36 0	0 6 21·8	0 7 0
26	8 52 57·85	8 48 0	1 36 0·1	1 31 0	0 7 2·25	0 2 0
27	8 53 0·9	8 50 0	1 36 1·75	1 33 0	0 7 2·8	0 4 0
28	8 53 8·8	8 55 0	1 36 6·8	1 38 0	0 7 6·3	0 9 0
29	8 53 56·0	8 53 0	1 35 56·5	1 35 0	0 6 57·4	0 6 0
30	8 54 52·5	9 7 0	1 36 47·75	1 49 0	0 6 41·45	0 19 0
31	8 55 6·95	8 51 0	1 37 8·2	1 33 0	0 7 9·4	0 3 0
32	8 55 4·6	8 58 0	1 37 2·8	1 40 0	0 7 0·5	0 10 0
33	8 55 6·85	8 55 0	1 37 7·5	1 37 0	0 7 7·4	0 7 0
34	8 56 4·5	8 56 0	1 38 4·8	1 38 0	0 8 5·7	0 8 0
35	8 56 23·3	8 58 0	1 38 22·8	1 40 0	0 8 21·8	0 10 0
36	8 48 38·2	8 50 0	1 32 37·6	1 34 0	0 5 36·8	0 7 0
37	8 48 43·4	8 49 0	1 32 42·75	1 33 0	0 5 41·75	0 6 0
38	8 48 47·55	9 1 0	1 32 45·2	1 45 0	0 5 42·3	0 18 0
39	8 49 50·85	9 0 0	1 32 45·9	1 43 0	0 5 39·7	0 16 0
40	8 49 59·8	8 53 0	1 32 58·6	1 36 0	0 5 56·8	0 9 0
†41	8 50 8·5 9 29 34·5	14 15 57·5 14 55 30·0	1 33 24·5 1 49 22·0	7 2 0 7 18 0	0 9 39·5 0 12 39·0	5 42 0 5 45 0
42	8 51 2·45	8 52 0	1 34 1·9	1 35 0	0 6 0·8	0 7 0
†43	8 45 5·5 9‡ 21 49·5	14 8 55·0 14‡ 44 45·0	1 29 25·5 1 46 22·5	6 56 0 7 13 0	0 11 41·0 0 14 40·5	5 42 0 5 45 0
44	8 47 11·5	8 45 0	1 30 12·0	1 28 0	0 5 12·7	0 3 0
45	8 46 44·95	8 44 0	1 29 47·25	1 25 0	0 4 50·7	0 0 0
46	8 47 39·85	8 50 0	1 31 36·4	1 34 0	0 4 31·8	0 7 0
47	8 47 38·8	8 32 0	1 31 46·5	1 16 0	0 4 56·75	23 49 0
48	8 47 29·8	8 39 0	1 31 33·5	1 23 0	0 5 39·8	23 57 0
49	8 48 32·85	8 48 0	1 31 31·75	1 31 0	0 5 30·75	0 5 0
50	8 50 32·75	8 23 0	1 37 28·6	1 33 0	0 7 26·2	0 3 0
51	8 49 40·7	8 49 0	1 33 40·8	1 33 0	0 5 40·75	0 5 0
52	8 55 44·85	8 40 0	1 37 45·6	1 22 0	0 7 46·8	23 52 0

* 51m in original.

† (41) and (43) are sidereal chronometers.

‡ The comparison 1m wrong; rejected.

The corrections of the Greenwich Mean-time Clock, kindly supplied by the Astronomer Royal, are as follow :—

1874, June 15, at	h.	m.	by clock.	Correction to Greenwich M.T.	s.
" " "	8	34	"		+0·05
" " "	9	48	"	" " "	+0·01
" " 16	0	44	"	" " "	+0·09
" " "	23	40	"	" " "	+0·09
" " 17	0	35	"	" " "	+0·06

Interpolating between these times when necessary, we get the following corrections to be applied to the chronometers to give Greenwich time.

Rotation No.	Corrections to Greenwich Time			Rotation No.	Corrections to Greenwich Time		
	June 15	June 16	June 17		June 15	June 16	June 17
	h. m. s.	h. m. s.	h. m. s.		h. m. s.	h. m. s.	h. m. s.
1	−0 2 44·61	−0 2 45·52	−0 2 46·12	28	−0 1 51·16	−0 1 53·12	−0 1 53·62
2	−0 5 32·66	−0 5 34·62	−0 5 37·62	29	+0 0 56·04	+0 0 56·58	+0 0 57·48
3	−0 5 11·26	−0 5 13·02	−0 5 15·72	30	−0 12 7·46	−0 12 12·17	−0 12 18·47
4	−0 4 55·06	−0 4 56·72	−0 4 59·22	31	+0 4 6·99	+0 4 8·28	+0 4 9·48
7	−0 5 14·76	−0 5 17·32	−0 5 19·92	32	−0 2 55·36	−0 2 57·12	−0 2 59·42
8	−0 1 58·76	−0 2 0·02	−0 2 1·52	33	+0 0 6·89	+0 0 7·58	+0 0 7·48
9	−0 2 39·66	−0 2 41·02	−0 2 43·17	34	+0 0 4·54	+0 0 4·88	+0 0 5·77
10	−0 4 56·71	−0 4 58·42	−0 5 1·12	35	−0 1 36·66	−0 1 37·12	−0 1 38·13
11	−0 5 58·66	−0 6 0·87	−0 6 4·22	36	−0 1 21·76	−0 1 22·32	−0 1 23·12
12	+0 0 8·75	+0 0 8·38	+0 0 8·78	37	−0 0 16·56	−0 0 17·17	−0 0 18·17
13	+0 0 48·65	+0 0 48·58	+0 0 48·73	38	−0 12 12·41	−0 12 14·72	−0 12 17·62
14	−0 2 4·75	−0 2 5·57	−0 2 6·12	39	−0 10 9·11	−0 10 14·02	−0 10 20·22
15	+0 1 24·45	+0 1 22·88	+0 1 20·98	40	−0 3 0·16	−0 3 1·32	−0 3 3·12
16	−0 1 26·55	−0 1 27·22	−0 1 28·17	41*	+0 10 1·89	+0 10 0·33	+0 9 58·05
17	−0 6 41·35	−0 6 44·02	−0 6 47·62	42	−0 0 57·51	−0 0 58·02	−0 0 59·12
18	−0 8 19·35	−0 8 22·52	−0 8 26·67	43*	+0 12 0·58	+0 12 0·50	+0 11 59·89
19	−0 1 4·90	−0 1 4·92	−0 1 5·12	44	+0 2 11·49	+0 2 12·08	+0 2 12·78
20	−0 4 49·80	−0 4 51·67	−0 4 54·12	45	+0 2† 44·99	+0 4 47·33	+0 4 50·78
21	−0 2 51·51	−0 2 52·52	−0 2 53·72	46	−0 2 20·11	−0 2 23·52	−0 2 28·12
22	−0 5 35·76	−0 5 39·12	−0 5 42·72	47	+0 15 38·84	+0 15 46·58	+0 15 56·83
23	−0 3 50·96	−0 3 53·12	−0 3 56·12	48	+0 8 29·84	+0 8 33·58	+0 8 39·88
24	−0 3 50·01	−0 3 52·02	−0 3 54·62	49	+0 0 32·89	+0 0 31·83	+0 0 30·83
25	−0 0 38·51	−0 0 38·52	−0 0 38·12	50	+0 27† 32·79	+0 4 28·68	+0 4 26·28
26	+0 4 57·89	+0 5 0·18	+0 5 2·33	51	+0 0 40·74	+0 0 40·88	+0 0 40·83
27	+0 3 0·94	+0 3 1·83	+0 3 2·88	52	+0 15 44·89	+0 15 45·68	+0 15 46·87

* Chronometers 41 and 43 are sidereal, and the corrections are to Greenwich sidereal time; the rest are mean-time chronometers, and their corrections to Greenwich mean time.

† Assumed as 4^m.

Operations at Suez.

Comparisons of Chronometers.

1874, July 6.

(43)			(50)		
h.	m.	s.	h.	m.	s.
7	48	34·5	1	0	0·0
7	53	35·5	1	5	0·0

(43)			(50)		
h.	m.	s.	h.	m.	s.
4	43	5·5	21	51	5·0
4	46	5·0	21	54	5·0

1874, July 7.

(43)			(50)		
h.	m.	s.	h.	m.	s.
11	30	40·0	4	37	33·0
11*	33	52·5	4*	40	50·0
11	36	52·0	4	43	44·0
2	26	8·0	19	30	35·0
2	29	14·5	19	33	41·0

(43)			(50)		
h.	m.	s.	h.	m.	s.
23	36	25·5	16	41	20·0
23	39	38·0	16	44	32·0
23	42	31·5	16	47	25·0
4	9	26·0	21	13	36·0

1874, July 8.

Before Observations.

(43)			(32)		
h.	m.	s.	h.	m.	s.
12	8	20·0	5	18	13·0
12	24	30·0	5	34	20·5
			(33)		
12	10	10·0	5	15	35·0
12	13	1·0	5	18	25·5
12	16	26·0	5	21	50·0
			(34)		
12	11	20·0	5	16	50·5
12	14	10·0	5	19	40·0
			(30)		
12	17	12·0	5	37	41·5
12	27	15·0	5	47	43·0
			(31)		
12	19	13·0	5	19	52·5
12	28	38·0	5	29	15·0
			(50)		
12	20	10·0	5	23	0·0
12	30	20·0	5	33	8·5
			(35)		
12	20	54·0	5	28	34·0
12	33	40·0	5	41	18·0

After Observations.

(43)			(32)		
h.	m.	s.	h.	m.	s.
17	0	5·0	10	9	11·0
17	6	46·0	10	15	51·0
			(33)		
16	54	32·0	9	59	10·5
17	10	20·0	10	14	56·0
			(34)		
16	53	5·0	9	57	49·5
16	56	0·0	10	0	44·0
			(30)		
16	58	55·0	10	18	40·0
17	8	37·0	10	28	20·5
			(31)		
17	1	37·0	10	1	30·0
17	7	53·0	10	7	45·0
			(50)		
16	55	27·0	9	57	32·0
17	11	10·0	10	13	12·5
			(35)		
17	4	54·0	10	11	48·0

The observations for time were made with one of Messrs. Troughton and Simms' 12-inch altazimuths, the telescope of which has a clear aperture of two inches. For the outward journey the adopted equatorial wire-intervals of the vertical wires from wire III. are, for Circle East :

I. $26^{s}\cdot77$. II. $13^{s}\cdot58$. IV. $13^{s}\cdot02$. V. $26^{s}\cdot20$.

One part of the scale of the axis level corresponds to $3''\cdot13$.

* One of these comparisons is 5^{s} wrong ; rejected.

Time Determinations at Suez.

The following observations of time stars in the vertical of a pole star were taken with the altazimuth. Observer, Mr. Gill; chronometer 43 :—

Date, 1874	Pole star	Position of circle	Chronometer time of pole star on wire III.	Level readings	Time star	Chronometer times of transit over wires					Level readings
						I.	II.	III.	IV.	V.	
			h. m. s.	E. p. W. p.		s.	s.	h. m. s.	s.	s.	E. p. W. p.
July 6	δ Urs. min.	W	16 0 20·0	19·0 12·9 / 22·6 9·2	α Lyræ	20·1	36·5	16 10 54·5	10·6	28·0	24·5 7·9 / 26·8 5·0
	α Urs. min.	E	16 26 56·0	19·0 13·3 / 21·5 10·8	ε Aquilæ	5·4	52·0	16 33 38·5	24·7	11·3	22·0 10·2 / 24·2 7·2
July 7	α Urs. min.	E	13 52 17·0	17·2 14·1 / 18·6 12·5	γ Herculis	41·4*	27·2	13 55 13·0	59·1	45·4	... ...
	" "	"	"	18·0 13·8 / 20·5 10·5	α Scorpii	16·1	1·5	14 3 47·0	32·0	17·0	20·5 10·9 / 20·1 11·4
	α Urs. min.	W	14 11 54·0	15·5 16·2 / 19·0 12·7	24 Scorpii	37·1	50·9	14 16 4·5	18·0	32·0	21·0 11·0 / 17·5 14·5
	δ Urs. min.	W	15 30 21·0	13·8 18·6 / 17·5 14·3	67 Ophiuchi	36·9	50·4	15 33 3·2	16·7	30·0	14·0 18·2 / 19·3 12·9
	" "	"	"	" "	72 Ophiuchi	29·9	43·5	15 39 57·2	10·3	23·4	20·5 12·2 / 15·0 17·5
	δ Urs. min.	E	15 46 57·5	17·1 15·9 / 21·1 11·0	η Serpentis	23·2	...	15 52 56·0	43·5	...	17·0 15·5 / 21·9 10·4
July 8	α Urs. min.	W	13 6 58·0	20·4 8·8 / 17·5 12·1	α Serpentis	1·5	14·4	13 17 28·4	41·5	55·2	24·5 6·0 / 20·0 10·2
	α Urs. min.	E	13 23 22·0	20·5 10·0 / 25·2 5·0	γ Serpentis	2·0	48·0	13 29 34·0	20·2	6·4	22·5 8·0 / 26·5 4·1
	α Urs. min.	W	13 41 24·5	12·2 18·5 / 9·0 21·8	δ Ophiuchi	37·7	51·0	13 48 4·4	17·5	30·7	10·5 20·5 / 13·2 17·5
	α Urs. min.	E	13 53 52·0	10·7 20·3 / 14·1 16·4	γ Herculis	38·4	24·0	13 55 9·5	55·6	...	10·7 20·3 / 16·0 15·0
	" "	"	"	" "	α Scorpii	14·5	59·7	14 3 45·0	29·8	15·3	17·2 13·8 / 13·0 18·5
	α Urs. min.	W	14 9 50·0	12·9 18·4 / 18·2 13·0	24 Scorpii	31·9	45·8	14 15 59·8	13·6	27·4	14·8 16·9 / 19·3 12·1
	δ Urs. min.	E	14 22 33·3	19·2 12·1 / 14·5 17·1	κ Ophiuchi	15·0	1·5	14 31 48·0	34·8	21·8	... ...
	" "	"	"	" "	ε Herculis	47·9	32·2	14 33 16·5	...	...	19·0 12·4 / 15·3 16·0
	δ Urs. min.	E	15 45 24·0	19·8 11·5 / 25·5 6·7	η Serpentis	25·0	11·6	15 52 58·0	45·1	32·0	25·5 6·8 / 22·5 10·0
	δ Urs. min.	E	16 2 29·5	13·8 18·6 / 18·5 14·0	α Lyræ	21·0	4·1†	16 10 46·4	30·2	12·6	14·9 18·1 / 19·8 13·0
	δ Urs. min.	W	16 17 30·0	15·2 17·2 / 20·2 12·4	β Lyræ	1·2	17·0	16 23 33·1	49·2	4·0	17·0 16·2 / 21·0 12·0

* 42ˢ·4 in original.

† 3ˢ·1 in original.

The reduction of the observations in the vertical of a pole star have been made in close accordance with Hansen's method[1] as given by Chauvenet.[2] In the first instance the chief correction $(t-m)$ was computed without regard to the collimation error. The coefficient of the collimation with respect to the time

$$C=\frac{\cos\{\frac{1}{2}\ (w'+w)-\phi'\}}{\cos n\cos\phi'\cos\frac{1}{2}(w'-w)}$$

including both its direct effect on the equatorial star and its indirect effect through the azimuth of the pole star, was then computed for each equatorial star, and the collimation, c, deduced from the observations in reversed positions of the instrument. The signs of the corrections are the reverse of those applied to ordinary transit observations; in other words, the corrections are to be applied as they stand to the approximate chronometer corrections. The final mean of the results in reversed positions of the instrument has been adopted as the final chronometer correction.

For the foregoing observations the epochs and assumed chronometer rates were :—

Date	Epoch by chronometer	Assumed chronometer rate	c
	h. m.	s.	s.
1874, July 6	16 22·2	+0·107 per hour	−1·308
„ „ 7	14 53·1	+0·108 „	−1·551
„ „ 8	14 33·0	„ „	−1·476

to which we have added the values of c, the collimation constant as deduced for each day.

The principal quantities of the reductions are exhibited in the subjoined table.

Date, 1874	Star	Position of circle	C	Concluded chronometer time of transit over wire III.	R.A. of star including daily aberration	Rate of chronometer to epoch	$(t-m)$	Cc	Chronometer correction
				h. m. s.	h. m. s.	s.	m. s.	s.	h. m. s.
July 6	α Lyræ	W	−1·063	16 10 54·23	18 32 42·75	+0·02	+0 9·17	+1·39	+2 21 59·10
	ε Aquilæ	E	+1·346	16 33 38·15	18 53 56·55	−0·02	+1 42·49	−1·76	59·14
July 7	γ Herculis	E	+1·287	13 55 12·98	16 16 23·86	+0·10	+0 52·43	−2·00	+2 22 1·31
	α Scorpii	„	+2·212	14 3 46·47	16 21 43·46	+0·09	+4 8·05	−3·43	1·61
	24 Scorpii	W	−1·960	14 16 4·74	16 34 19·58	+0·07	+3 43·79	+3·04	1·67
	67 Ophiuchi	„	−1·498	15 33 3·67	17 54 22·41	−0·07	+0 40·40	+2·32	1·46
	72 Ophiuchi	„	−1·403	15 39 57·09	18 1 24·92	−0·08	+0 31·53	+2·18	1·54
	η Serpentis	E	+1·591	15 52 56·31	18 14 49·84	−0·11	+0 10·50	−2·47	1·56
July 8	α Serpentis	W	−1·473	13 17 28·43	15 38 5·73	+0·14	+1 24·51	+2·17	+2 22 3·98
	γ Serpentis	E	+1·334	13 29 33·89	15 50 40·07	+0·11	+0 59·97	−1·97	4·18
	δ Ophiuchi	W	−1·650	13 48 4·49	16 7 46·72	+0·08	+2 19·04	+2·44	3·71
	γ Herculis	E	+1·287	13 55 9·63	16 16 23·85	+0·07	+0 51·49	−1·90	3·81
	α Scorpii	„	+2·212	14 3 44·61	16 21 43·44	+0·05	+4 8·54	−3·27	4·10
	24 Scorpii	W	−1·960	14 15 59·94	16 34 19·60	+0·03	+3 41·71	+2·89	4·26
	κ Ophiuchi	E	+1·404	14 31 47·99	16 51 44·47	0·00	+2 9·77	−2·07	4·18
	ε Herculis	„	+1·142	14 33 16·48	16 55 30·44	0·00	−0 8·25	−1·69	4·02
	η Serpentis	„	+1·591	15 52 58·11	18 14 49·84	−0·14	+0 15·06	−2·35	4·44
	α Lyræ	„	+1·063	16 10 46·57	18 32 42·78	−0·18	+0 9·45	−1·57	4·09
	β Lyræ	W	−1·120	16 23 33·17	18 45 28·03	−0·20	+0 8·03	+1·65	4·54

[1] *Ast. Nach.*, Band 48, p. 120.

[2] *A Manual of Spherical and Practical Astronomy.* By William Chauvenet, 4th edition (London and Philadelphia, 1868), vol. ii. p. 215 *et seq*

Taking the means, we get the following :—

Date	Epoch by chronometer		Chronometer correction to local sidereal time					
	h.	m.		h.	m.	s.	h.	m.	s.
1874, July 6	16	22·2	Circle E.	+2	21	59·140	+2	21	59·12
			„ W.			59·100			
„ „ 7	14	53·1	Circle E.	+2	22	1·493	+2	22	1·525
			„ W.			1·557			
„ „ 8	14	33·0	Circle E.	+2	22	4·117	+2	22	4·12
			„ W.			4·122			

Assuming the longitude of the observing station at Suez to be $2^h\ 10^m\ 12^s{\cdot}76$ [3] east of Greenwich, and using the preceding corrections and resulting rates of chronometer 43, we get from the comparisons by coincident beats of this chronometer with chronometer 50, the following corrections of the latter to Greenwich mean time [4] :—

Date	Epoch by chronometer 50		Correction of chronometer 50		
	h.	m.	h.	m.	s.
1874, July 6	1	2·5	+0	2	58·19
„ „	21	54·1		2	59·81
„ July 7	4	40·6		3	1·23
„ „	16	44·4		3	2·15
„ „	19	32·1		3	2·16
„ „	21	13·6		3	2·43
„ July 8	5	28·1		3	2·86
„ „	10	5·4		3	3·30

We have also the corrections of the seven chronometers, No. 50 included, that were compared with chronometer 43 before and after the observations on July 8. The rates of these chronometers have been found by the aid of their corrections subsequently determined at Aden, using the telegraphic difference of longitude.

Date	Rotation number	Epoch by chronometer		Correction of chronometer to Greenwich mean time			Approximate daily rate
		h.	m.	h.	m.	s.	s.
1874, July 8	(30)	8	3·1	−0	14	36·715	−6·092
„ „	(31)	7	44·6	+0	5	14·19	+4·398
„ „	(32)	7	49·4	−0	3	58·34	−1·913
„ „	(33)	7	42·8	+0	0	29·745	+1·705
„ „	(34)	7	38·8	+0	0	24·05	+1·406
„ „	(35)	7	53·2	−0	1	47·215	+0·268
„ „	(50)	7	46·7	+0	3	3·08	+1·738

Carrying these corrections back, we get the corrections of chronometer 50 from each of these chronometers about the time of comparison with all the chronometers as follow :—

Date	By chronometer	Epoch by chronometer 50		Correction of chronometer 50 to Greenwich mean time		
		h.	m.	h.	m.	s.
1874, July 7	(30)	20	30	+0	3	2·14
„ „	(31)	„				2·22
„ „	(32)	„				1·60
„ „	(33)	„				2·10
„ „	(34)	„				2·40
„ „	(35)	„				2·16
„ „	(43)	„				2·30
„ „	By its own rate	„				2·26

Therefore,

h.	m.		h.	m.	s.
at 20	30 by chronometer 50, correction to Greenwich mean time		+0	3	2·15

We can now find the corrections of all the chronometers to Greenwich mean time.

[3] See *Summary of Longitudes.*

[4] It was found most convenient to use Greenwich time throughout, to facilitate the calculation of the rates between the various stations whose longitudes were determined telegraph.

COMPARISONS OF CHRONOMETERS WITH THE STANDARD (50).

Rotation No.	1874, JULY 6		1874, JULY 7		Rotation No.	1874, JULY 6		1874, JULY 7	
	Time by (50)	Seconds of compared chronometer	Time by (50)	Seconds of compared chronometer		Time by (50)	Seconds of compared chronometer	Time by (50)	Seconds of compared chronometer
	h. m. s.	s.	h. m. s.	s.		h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	20 5 0	10·4	19 38 0	12·7	27	20 45 0	41·5	20 11 0	35·0
2	„	52·0	„	57·45	28	„	14·8	„	15·8
3	„	8·35	„	13·0	29	„	30·0	„	28·75
4	„	43·9	„	46·9	30	21 7 0	28·5	20 30 0	36·0
7	„	42·9	„	49·3	31	„	52·45	„	50·1
8	„	38·3	„	41·5	32	„	55·0	„	59·05
9	„	21·9	„	25·05	33	„	32·7	„	33·15
10	„	1·9	„	6·25	34	„	38·7	„	39·0
11	„	31·25	„	37·5	35	„	48·0	„	49·5
12	20 24 0	46·75	19 56 0	47·0	36	21 20 0	58·3	20 40 0	2·15
13	„	15·3	„	16·2	37	„	33·4	„	35·45
14	„	30·5	„	32·3	38	„	8·0	„	11·95
15	„	36·95	„	41·7	39	„	53·4	„	0·45
16	„	52·2	„	54·0	40	„	37·45	„	40·0
17	„	0·45	„	4·85	41*	21 20 25·0 21 26 25·0	4 14 39·5 4 20 40·5	20 39 0·0 20 47 54·0	3 37 7·0 3 46 2·5
18	„	10·05	„	16·75	42	21 20 0	0·0	20 40 0	1·9
19	„	51·7	„	52·5	44	„	42·5	21 2 0	43·5
20	„	53·5	„	58·0	45	„	10·25	„	8·5
21	20 45 0	5·5	20 11 0	7·25	46	„	59·5	„	4·7
22	„	31·95	„	34·1	47	„	6·0	„	54·5
23	„	32·0	„	33·5	48	„	21·15	„	17·4
24	„	37·5	„	37·55	49	„	7·7	„	11·3
25	„	2·0	„	5·5	51	„	5·8	„	4·3
26	„	58·5	„	56·0	52	„	4·0	„	4·6

* Chronometer 41 is regulated to sidereal time.

From the preceding comparisons (supplying the hours and minutes when necessary) and the adopted corrections of chronometers 43 and 50, we get the following corrections of all the chronometers to Greenwich time :—

Rotation No.	1874, July 6	1874, July 7	Rotation No.	1874, July 6	1874, July 7
	Chronometer correction	Chronometer correction		Chronometer correction	Chronometer correction
	h. m. s.	h. m. s.		h. m. s.	h. m. s.
1	−0 3 10·80	−0 3 10·61	28	−0 2 15·12	−0 2 13·67
2	−0 6 52·40	−0 6 55·36	29	+0 1 29·68	+0 1 33·38
3	−0 6 8·75	−0 6 10·91	30	−0 14 28·78	−0 14 33·85
4	−0 5 44·30	−0 5 44·81	31	+0 5 7·27	+0 5 12·05
7	−0 6 43·30	−0 6 47·21	32	−0 3 55·28	−0 3 56·90
8	−0 2 38·70	−0 2 39·41	33	+0 0 27·02	+0 0 29·00
9	−0 3 22·35	−0 3 22·96	34	+0 0 21·02	+0 0 23·15
10	−0 6 2·30	−0 6 4·16	35	−0 1 48·28	−0 1 47·35
11	−0 7 31·65	−0 7 35·41	36	−0 1 58·56	−0 1 59·99
12	+0 0 12·89	+0 0 15·11	37	−0 0 33·66	−0 0 33·29
13	+0 0 44·34	+0 0 45·91	38	−0 13 8·26	−0 13 9·79
14	−0 2 30·86	−0 2 30·19	39	−0 11 53·66	−0 11 58·29
15	+0 0 22·69	+0 0 20·41	40	−0 3 37·71	−0 3 37·84
16	−0 1 52·56	−0 1 51·89	41*	+0 9 27·58	+0 9 27·26
17	−0 8 0·81	−0 8 2·74	42	−0 1 0·26	−0 0 59·74
18	−0 10 10·41	−0 10 14·64	43*	+0 11 46·36	... ...
19	−0 0 52·06	−0 0 50·39	44	+0 2 17·24	+0 2 18·69
20	−0 5 53·86	−0 5 55·89	45	+0 5 49·49	+0 5 53·69
21	−0 3 5·82	−0 3 5·12	46	−0 3 59·76	−0 4 2·51
22	−0 6 32·27	−0 6 31·97	47	+0 19 53·74	+0 20 7·69
23	−0 4 32·32	−0 4 31·37	48	+0 10 38·59	+0 10 44·79
24	−0 4 37·82	−0 4 35·42	49	−0 0 7·96	−0 0 9·11
25	−0 1 2·32	−0 1 3·37	50	+0 2 59·81	+0 3 2·15
26	+0 6 1·18	+0 6 6·13	51	+0 0 53·94	+0 0 57·89
27	+0 4 18·18	+0 4 27·13	52	+0 15 55·74	+0 15 57·59

* The chronometers 41 and 43 are regulated to sidereal time.

Operations at Aden.

Comparisons of Chronometers.

1874, July 18.

(43)	(50)	(43)	(50)
h. m. s.	h. m. s.	h. m. s.	h. m. s.
8 18 25·5	0 42 50·0	9 27 50·0	1 52 3·0
		9 33 48·0	1 58 0·0

After Observations.

(43)	(36)	(43)	(37)
h. m. s.	h. m. s.	h. m. s.	h. m. s.
15 38 5·0	8 7 15·0	15 41 0·0	8 8 9·5
(43)	(42)	(43)	(41)
h. m. s.	h. m. s.	h. m. s.	h. m. s.
15 44 53·0	8 11 22·0	15 42 0·0	15 45 2·0

1874, July 19.

(43)	(50)
h. m. s.	h. m. s.
9 39 20·5*	1 59 40·0
9 53 13·0	2 13 28·0

Time Determinations.

The following observations of time stars in the vertical of the pole star were taken with the Troughton and Simms altazimuth. Observer, Mr. Gill ; chronometer, 43.

Date, 1874	Pole star	Position of circle	Chronometer time of pole star on wire III.	Level readings	Time star	Chronometer times of transit over wires					Level readings
						I.	II.	III.	IV.	V.	
			h. m. s.	E. p. W. p.		s.	s.	h. m. s.	s.	s.	E. p. W. p.
July 18	*a* Urs. min.	W	12 35 54·0	11·2 17·5 / 16·2 12·0	κ Herculis	22·3	36·0	12 49 50·1	3·9	17·7	… …
	„ „	„	„	„ „	δ Ophiuchi	1·6	15·2	12 56 28·6	41·6	55·0	12·2 17·4 / 15·4 13·5
	a Urs. min.	E	13 7† 38·0	12·0 17·7 / 14·2 15·0	*a* Scorpii	40·7	25·8	13 12 11·0	56·5	42·0	11·3 18·2 / 15·2 14·3
	a Urs. min.	W	13 19 28·0	11·8 18·0 / 15·4 14·3	ζ Herculis	6·6	22·3	13 22 38·1	53·2	9·1	12·2 17·7 / 16·4 13·3
	a Urs. min.	E	13 29 11·0	14·8 15·1 / 20·1 9·4	κ Ophiuchi	5·7	52·5	13 39 38·5	25·5	12·5	16·0 14·5 / 20·0 10·1
	„ „	„	„	„ „	*a* Herculis	55·1	41·4	13 56 27·5	14·2	1·0	20·8 9·1 / 16·4 13·7
	a Urs. min.	W	14 6 26·0	19·9 9·8 / 16·8 13·9	*a* Ophiuchi	24·0	37·5	14 16 51·3	4·9	17·9	20·5 9·2 / 17·0 13·0

* One of these comparisons is wrong.

† 2^m in original.

From the foregoing observations we get :—

Date	Epoch by chronometer	Assumed chronometer rate	c.
	h. m.	s.	s.
1874, July 18	13 28·8	+0·131 per hour	−2·010

Observer, Mr. Gill ; chronometer, 43.

Date, 1874	Star	Position of circle	C.	Concluded chronometer time of transit over wire III.	R.A. of star, including daily aberration	Rate of chronometer to epoch	T–m.	Cc.	Chronometer correction
				h. m. s.	h. m. s.	s.	m. s.	s.	h. m. s.
July 18	κ Herculis	W	−0·961	12 49 50·24	16 2 25·31	+0·09	−0 17·76	+1·93	+3 12 19·24
	δ Ophiuchi	„	−1·293	12 56 28·63	16 7 46·68	+0·07	+0 58·46	+2·60	19·11
	α Scorpii	E	+1·852	13 12 10·95	16 21 43·42	+0·04	+2 50·79	−3·72	19·54
	ζ Herculis	W	−0·780	13 22 38·13	16 36 34·40	+0·01	−1 38·46	+1·57	19·38
	κ Ophiuchi	E	+1·073	13 39 38·71	16 51 44·43	−0·02	+0 15·66	−2·16	19·22
	α Herculis	„	+1·000	13 56 27·61	17 8 56·41	−0·06	−0 7·67	−2·01	19·12
	α Ophiuchi	W	−1·028	14 16 51·35	17 29 7·44	−0·10	+0 1·47	+2·07	19·63

Taking the means, we get :—

Date	Epoch by chronometer	Chronometer correction to local sidereal time		
	h. m.	h. m. s.	h. m. s.	
1874, July 18 . . .	13 28·8	Circle E, +3 12 19·293 „ W, 19·340	+3 12 19·32	

Assuming the longitude of the observing station at Aden to be $2^h\ 59^m\ 56^s{\cdot}51$ [5] east of Greenwich, and assuming the *daily* rate of chronometer 43 to be $+3^s{\cdot}159$, we get from the comparisons by coincident beats the following corrections of chronometer 50 to Greenwich mean time :—

Date	Epoch by chronometer 50	Correction of chronometer 50
	h. m.	h. m. s.
1874, July 18	0 42·8	+0 3 19·84
„ „ 18	1 55·0	20·14
„ „ 19	2 13·5	21·25

and also the corrections of the chronometers compared with chronometer 43, and from the corrections at Suez (p. 57) their approximate rates as follow :—

Date	Rotation No.	Epoch by chronometer	Correction of chronometer to Greenwich time	Approximate daily rate
		h. m.	h. m. s.	s.
1874, July 18 . . .	(36)	8 7·0	−0 2 23·23	−2·219
	(37)	8 8·2	−0 0 36·70	−0·326
	(41)*	15 45·0	+0 9 21·10	−0·587
	(42)	8 11·4	+0 0 3·17†	...

Using the preceding corrections and rates, we get from the daily comparisons (supplying minutes for chronometers 36 and 37) the following corrections of chronometer 50 to Greenwich mean time :—

[5] See Chap. XIII.

* Chronometer 41 is regulated to sidereal time.

† This correction is 1^m wrong, and in consequence cannot be used.

Date	By chronometer	Epoch by chronometer 50	Correction of chronometer 50
		h. m.	h. m. s.
1874, July 18	(36)	1 30	+0 3 19·87
	(37)	,,	19·89
	(41)	,,	19·89
	(43)	,,	20·00
,, July 19	(36)	1 44	+0 3 21·63
	(37)	,,	21·56
	(41)	,,	22·15
	(43)	,,	21·21

Taking the means, we have :—

			Hourly rate
	h. m.	h. m. s.	s.
July 18 at 1	30 by chronometer 50, correction to Greenwich mean time	+0 3 19·91	+0·0714
,, 19 ,, 1	44 ,, ,, ,, ,,	21·64	

Using these corrections and rate, we can find the corrections of all the chronometers to Greenwich time.

Comparisons of chronometers with the standard (50) :—

Rotation No.	1874, July 18		1874, July 19		Rotation No.	1874, July 18		1874, July 19	
	Time by (50)	Seconds of compared chronometer	Time by (50)	Seconds of compared chronometer		Time by (50)	Seconds of compared chronometer	Time by (50)	Seconds of compared chronometer
	h. m.	s.	h. m. s.	s.		h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	0 38 0	36·5	0 53 0	39·0	27	1 7 0	11·5	1 20 0	1·2
2	,,	50·75	,,	56·05	28	,,	22·25	,,	21·2
3	,,	58·2	,,	2·5	29	,,	10·75	,,	9·0
4	,,	14·5	,,	17·1	30	1 20 0	56·0	1 32 0	4·2
7	,,	38·2	,,	43·2	31	,,	23·0	,,	20·0
8	,,	13·8	,,	17·5	32	,,	36·95	,,	41·4
9	,,	56·15	,,	56·95	33	,,	33·65	,,	34·1
10	,,	50·2	,,	54·8	34	,,	42·25	,,	42·8
11	,,	38·6	,,	45·5	35	,,	4·6	,,	5·55
12	0 53 0	50·8	1 6 0	51·5	36	1 30 0	42·5	1 44 0	46·5
13	,,	17·5	,,	18·0	37	,,	56·5	,,	58·5
14	,,	36·9	,,	37·5	38	,,	45·85	,,	49·2
15	,,	18·5	,,	19·85	39	,,	3·3	,,	11·5
16	,,	8·8	,,	10·05	40	,,	4·9	,,	7·5
17	,,	51·5	,,	56·2	41	1 28 56·0	9 7 40·0	{1 44 34·0 1 56 41·0}	{9 27 20·0 9 39 29·0}
18	,,	19·3*	,,	25·8	42	1 30 0	16·5	1 44 0	18·1
19	,,	58·8	,,	59·5	44	2† 20 0	54·0	2 6 0	55·45
20	,,	48·0	,,	52·0	45	,,	46·35	,,	44·2
21	1 7 0	25·95	1 20 0	27·9	46	,,	56·5		2·3
22	,,	45·0	,,	45·0	47	,,	48·75	,,	36·05
23	,,	41·75	,,	42·7	48	,,	15·55	,,	9·5
24	,,	17·1	,,	15·0	49	,,	45·2	,,	48·8
25	,,	38·95	,,	41·95	51	,,	58·0	,,	57·0
26	,,	26·15	,,	22·5	52	,,	5·5	,,	5·2

* 29ˢ·3 in original.

† 1ʰ 20ᵐ in original.

From the preceding comparisons (supplying the hours and minutes where necessary) we get the following corrections of the chronometers to Greenwich time :—

Rotation No.	1874, July 18	1874, July 19	Rotation No.	1874, July 18	1874, July 19
	Chronometer correction	Chronometer correction		Chronometer correction	Chronometer correction
	h. m. s.	h. m. s.		h. m. s.	h. m. s.
1	−0 3 16·65	−0 3 17·42	28	−0 2 2·37	−0 1 59·59
2	−0 7 30·90	−0 7 34·47	29	+0 2 9·13	+0 2 12·61
3	−0 6 38·35	−0 6 40·92	30	−0 15 36·10	−0 15 42·57
4	−0 5 54·65	−0 5 55·52	31	+0 5 56·90	+0 6 1·63
7	−0 7 18·35	−0 7 21·62	32	−0 4 17·05	−0 4 19·77
8	−0 2 53·95	−0 2 55·92	33	+0 0 46·25	+0 0 47·53
9	−0 3 36·30	−0 3 35·37	34	+0 0 37·65	+0 0 38·83
10	−0 6 30·35	−0 6 33·22	35	−0 1 44·70	−0 1 43·92
11	−0 8 18·75	−0 8 23·92	36	−0 2 22·59	−0 2 24·86
12	+0 0 29·07	+0 0 30·09	37	−0 0 36·59	−0 0 36·86
13	+0 1 2·37	+0 1 3·59	38	−0 13 25·94	−0 13 27·56
14	−0 2 17·03	−0 2 15·91	39	−0 12 43·39	−0 12 49·86
15	+0 0 1·37	+0 0 1·74	40	−0 3 44·99	−0 3 45·86
16	−0 1 48·93	−0 1 48·46	41	+0 9 21·28	+0 9 20·15
17	−0 8 31·63	−0 8 34·61	42	−0 0 56·59	−0 0 56·46
18	−0 10 59·43	−0 11 4·21	43	... ...	... ...
19	−0 0 38·93	−0 0 37·91	44	+0 2 25·97	+0 2 26·22
20	−0 6 28·13	−0 6 30·41	45	+0 6 33·62	+0 6 37·47
21	−0 3 6·07	−0 3 6·29	46	−0 4 36·53	−0 4 40·63
22	−0 6 25·12	−0 6 23·39	47	+0 22 31·22	+0 22 45·62
23	−0 4 21·87	−0 4 21·09	48	+0 12 4·42	+0 12 12·17
24	−0 3 57·22	−0 3 53·39	49	−0 0 25·23	−0 0 27·13
25	−0 1 19·07	−0 1 20·34	50	+0 3 19·97	+0 3 21·67
26	+0 6 53·73	+0 6 59·11	51	+0 1 21·97	+0 1 24·67
27	+0 6 8·38	+0 6 20·41	52	+0 16 14·47	+0 16 16·47

Taking the means of July 18 and 19, giving double weight to the 18th, as being nearer to the time of the observations, we finally get the following corrections of the chronometers to Greenwich time :—

1874, JULY 18.

Rotation No.	Time by (50)	Chronometer correction	Rotation No.	Time by (50)	Chronometer correction
	h. m. s.	h. m. s.		h. m. s.	h. m. s.
1	8 43 0	−0 3 16·91	28	9 11 0	−0 2 1·44
2	,,	−0 7 32·09	29	,,	+0 2 10·29
3	,,	−0 6 39·21	30	9 24 0	−0 15 38·26
4	,,	−0 5 54·94	31	,,	+0 5 58·48
7	,,	−0 7 19·44	32	,,	−0 4 17·96
8	,,	−0 2 54·61	33	,,	+0 0 46·68
9	,,	−0 3 35·99	34	,,	+0 0 38·04
10	,,	−0 6 31·31	35	,,	−0 1 44·44
11	,,	−0 8 20·47	36	9 35 0	−0 2 23·35
12	8 57 0	+0 0 29·41	37	,,	−0 0 36·68
13	,,	+0 1 2·78	38	,,	−0 13 26·48
14	,,	−0 2 16·66	39	,,	−0 12 45·55
15	,,	+0 0 1·49	40	,,	−0 3 45·28
16	,,	−0 1 48·77	41*	17 16 0	+0 9 20·90
17	,,	−0 8 32·62	42	9 35 0	−0 0 56·55
18	,,	−0 11 1·02	43*	13 29 0	+0 12 22·81
19	,,	−0 0 38·59	44	10 15 0	+0 2 26·05
20	,,	−0 6 28·89	45	,,	+0 6 34·90
21	9 11 0	−0 3 6·14	46	,,	−0 4 37·90
22	,,	−0 6 24·54	47	,,	+0 22 36·02
23	,,	−0 4 21·61	48	,,	+0 12 7·00
24	,,	−0 3 55·94	49	,,	−0 0 25·86
25	,,	−0 1 19·49	50	,,	+0 3 20·54
26	,,	+0 6 55·52	51	,,	+0 1 22·87
27	,,	+0 6 12·39	52	,,	+0 16 15·14

* The chronometers 41 and 43 are regulated to sidereal time. The times given for *these* chronometers are their own, and their corrections are in sidereal time.

Time Determinations at Fort George, Mauritius.

The following fragmentary observations of altitudes of stars were taken with the Troughton and Simms altazimuth for time on first arrival at Mauritius; almost incessant clouds precluded all attempts at obtaining more satisfactory results. Observer, Mr. Gill; chronometer, 43.

Date, 1874	Name of star	Star E. or W. of meridian	Position of circle	Level readings	Chronometer times of transit over wires					Microscope readings of preceding and following divisions				Pointer reading	Level readings
					I.	II.	III.	IV.	V.	C	D	E	F		
				p. p.	h. m. s.	s.	s.	s.	s.	′ ″	′ ″	′ ″	° ′		p. p.
Aug. 4	*a* Virginis	W	L	I. +17·1 −20·8 II. +20·6 −17·9	12 59 10·0	55·8	42·1	27·5	13·4	46·0 1 47·5	9·8 2 6·5	... ...	... ...	...	... ...
	a Scorpii	W	L	... ...	14 17 11·5	56·6	42·4	26·6	12·5	... ...	20·2 4 22·1	41·5 4 42·0	... ...	351 10	I. +23·9 −14·0 II. +29·0 − 9·2
	a Scorpii	W	R	I. +12·9 −26·0 II. +11·5 −26·5	14 23 39·5	44·7	...	25·0	38·5	... ...	56·0 2 56·0	... ...	15·0 3 12·5	48 25	... ...
Aug. 6	*a* Virginis	W	L	I. +13·9 −24·0 II. +16·1 −22·2	... 11·0	57·0	43·4	28·6	15·2	... ...	2·2 3 1·9	... ...	11·1 3 10·5	324 0	I. +16·0 −22·3 II. +13·9 −24·0
	a^2 Capricorni	E	L	I. +16·0 −29·9 II. +17·6 −21·0	14 32 51·5	5·4	20·5	35·4	49·0	... ...	48·8 4 51·8	3·6 0 3·6	... ...	355 15 355 20	I. +16·1 −21·2 II. +19·0 −19·2
	a Scorpii	W	L	I. +23·0 −15·0 II. +17·0 −21·5	15 32 1·5	46·8	32·0	17·0	3·0	... ...	8·9 2 8·5	... ...	19·8 2 18·4	334 25	I. +17·0 −21·1 II. +17·0 −21·2

The observations given above are exactly as they are entered in the original observing-book, but, as will be seen further on, some of the readings are erroneous, chiefly from transpositions.

The intervals of the wires from the centre wire are Circle *Left*: Star *East*.

I.	II.	IV.	V.
s.	s.	s.	s.
26·03	12·80	13·81	26·59

The probable error of one of these wire intervals is about $\pm 0^s\cdot 03$.

The values of one division of the levels are—

I.	II.
″	″
2·74	2·02

The latitude of the station, Martello Tower, Fort George, −20° 8′ 37″, has been taken from the Admiralty Chart of Port Louis, Mauritius, surveyed by Nav. Lieut. J. E. Coghlan, R.N., 1877.

Corrections for Level.

From a careful examination of the level readings it seems extremely probable that on Aug. 4, α Scorpii, circle R, and on August 6, α Virginis (2nd reading), the levels have been interchanged, I. for II., and *vice versâ*. On Aug. 6, α Scorpii (1st reading), the readings of level I. have been transposed, and in the 2nd reading level II. has been read twice and level I. not at all. Assuming these alterations, we get the following table, where the difference level I.–level II. should be nearly a constant, the two levels being carried by the same microscope-frame :—

Date, 1874	Name of star	Position of circle	Level I.		Length of bubble	Correction for level	Level II.		Length of bubble	Correction for level	Level I. minus level II.	Total correction for level adopted
			p.	p.	p.	″	p.	p.	p.	″	″	″
Aug. 4	α Virginis	L	+17·1	−20·8	37·9	− 5·07	+20·6	−17·9	38·5	+2·73	−7·80	−1·17
	α Scorpii	L	+23·9	−14·0	37·9	+13·56	+29·0	− 9·2	38·2	+20·00	−6·44	+16·78
	,,	R	+11·5	−26·5	38·0	−20·55	+12·9	−26·0	38·9	−13·23	−7·32	−16·89
Aug. 6	α Virginis	L	+13·9	−24·0	37·9	−13·84	+16·1	−22·2	38·3	−6·16	−7·68	−10·05
	,,	,,	+13·9	−24·0	37·9	−13·84	+16·0	−22·3	38·3	−6·36	−7·48	
	α^2 Capricorni	L	+16·0	−21·9	37·9	[− 8·08*]	+17·6	−21·0	38·6	[−3·43]*	[−4·65]*	−3·60
	,,	,,	+16·1	−21·2	37·3	− 6·99	+19·0	−19·2	38·2	−0·20	−6·79	
	α Scorpii	L	+15·0	−23·0	38·0	−10·96	+17·0	−21·5	38·5	−4·54	−6·42	−7·75
	,,	,,	...	...	...	...	+17·0	−21·1	38·1	[−4·14]*	...	
	,,	,,	...	...	...	...	+17·0	−21·2	38·2	[−4·24]*	...	

* [ ] Not used.

Division Errors, including Excentricity.

The division errors of the vertical circle, including excentricity, were deduced from eighteen complete measures of zenith distance subsequently made for finding the latitude of Pamplemousses.

The corrected reading of any microscope was found to be

$$=u+1''\cdot84\cos u-0''\cdot75\sin u+2''\cdot73\cos 2u+0''\cdot02\sin 2u,$$

where u is the actual division under the microscope.

For microscope D

$$u=\text{pointer reading}+116^\circ\ 13'.$$

The following table gives the correction for every tenth degree :—

u	Correction	u	Correction	u	Correction	u	Correction
°	″	°	″	°	″	°	″
0	+4·57	90	−3·48	180	+0·89	270	−1·98
10	+4·24	100	−3·62	190	+0·88	280	−1·50
20	+3·57	110	−3·43	200	+0·63	290	−0·77
30	+2·59	120	−2·95	210	+0·17	300	+0·19
40	+1·42	130	−2·24	220	−0·44	310	+1·26
50	+0·16	140	−1·44	230	−1·06	320	+2·34
60	−1·07	150	−0·63	240	−1·61	330	+3·31
70	−2·15	160	+0·09	250	−2·01	340	+4·07
80	−2·98	170	+0·62	260	−2·14	350	+4·50
90	−3·48	180	+0·89	270	−1·98	360	+4·57

As D was the only microscope read for all the stars, after several preliminary computations it was decided to use only the readings of this microscope. On August 4 there is no pointer reading given for α Virginis, and as it is otherwise discordant the observation has been rejected. The apparent star-places and remaining data[6] are :—

		α			δ			Zenith Point		
		h.	m.	s.	°	′	″	°	′	″
1874, Aug. 4	α Scorpii	16	21	43·25	−26	9	14·63	19	1	16·41
Aug. 6	α Virginis	13	18	34·24	−10	30	19·69	19	1	11·75
,,	α^2 Capricorni	20	11	6·67	−12	55	58·17	,,		
,,	α Scorpii	16	21	43·23	−26	9	14·63	,,		

	Barometer	Attached thermometer	Exterior thermometer
	in.	°	°
Aug. 4	30·364	67·7	69·8
Aug. 6	,, 30·382	,, ,, 67·7	,, ,, 69·7

Using these we have computed :—

Date, 1874	Name of star	Position of circle	Circle reading by microscope D.	Excentricity	Correction for level	Apparent Z. D.	Refraction	Hour angle	Local sidereal time	Time by chronometer	Chronometer correction
			° ′ ″	″	″	° ′ ″	′ ″	h. m. s.	h. m. s.	h. m. s.	h. m. s.
Aug. 4	α Scorpii	L	351 14 20·45	−3·52	+16·78	27 46 42·70	+0 29·86	1 58 18·61	18 20 1·86	14 16 42·27	+4 3 19·59
	α Scorpii	R	48 27 56·00	+0·36	−16·89	29 26 23·06	+0 31·99	2 5 45·14	18 27 28·39	14 24 8·80	19·59
Aug. 6	α Virginis	L	324 3 2·08	−2·99	−10·05	54 58 22·71	+1 20·75	3 45 35·65	17 4 9·89	13 0*43·37	+4 3 26·52
	α^2 Capricorni	L	355 19 48·91	−3·38	−3·60	23 41 29·82	+0 24·89	1 34 19·82	18 36 46·85	14 33 20·02	26·83
	α Scorpii	L	334 27 8·68	−3·50	−7·75	44 34 14·32	+0 55·84	3 13 16·25	19 34 59·48	15 31 32·41	27·07

* Hour and minute supplied.

Taking the means, we get :—

Date	Epoch by chronometer		Chronometer correction to local sidereal time					
	h.	m.		h.	m.	s.	h.	m.	s.
1874, Aug. 4	14	20·4					+4	3	19·59
1874, Aug. 6	14	24·7	Stars W	+4	3	26·79			26·81
			Star E			26·83			

Owing to there being no direct determination of the difference of longitude between Fort George and Pamplemousses, these observations have not been used for the determination of the longitude of Mauritius ; they however confirm the result derived at Pamplemousses on August 7, about which there was at first some doubt, as will be seen further on.

[6] The barometer and thermometer readings are deduced from observations made at Pamplemousses, and obligingly supplied by Dr. Meldrum.

Operations at Pamplemousses.

Comparisons of Chronometers.

1874, August 6.

(43)	(36)	(43)	(37)
h. m. s.	h. m. s.	h. m. s.	h. m. s.
10 42 26·0	1 59 12·5	10 39 50·0	1 54 24·5
(43)	**(41)**	**(43)**	**(42)**
h. m. s.	h. m. s.	h. m. s.	h. m. s.
10 41 0·0	10 45 49·0	10 48 27·0	2 3 10·0
10 45 0·0	10 49 49·0		

1874, August 7.

(43)	(36)	(43)	(37)
h. m. s.	h. m. s.	h. m. s.	h. m. s.
18 54 19·0	10 5 55·0	18 51 47·0	10 1 10·0
18 57 0·0	10 8 45·5*	18 58 21·0	10 7 43·0
(43)	**(41)**	**(43)**	**(42)**
h. m. s.	h. m. s.	h. m. s.	h. m. s.
18 56 0·0	19 0 57·7	18 52 53·0	10 2 25·0
19 0 0·0	19 4 57·6	18 59 15·0	10 8 46·0

The chronometers 41 and 43 are regulated to sidereal time.

Time Determinations.

The following observations were taken with Mr. Meldrum's transit instrument at the Royal Alfred Observatory, Pamplemousses. Observer, Mr. Gill ; chronometer, 43.

Date, 1874	Name of star	Position of lamp	Chronometer times of transit over wires							Level readings	
			I.	II.	III.	IV.	V.				
			s.	s.	s.	s.	h.	m.	s.	E	W
										At 16h 56m	
										p.	p.
Aug. 7	61¹ Cygni	W	21·7	59·0	35·0	10·2	17	3	48·0	39·0	25·3
										34·0	29·6
	ζ Cygni	,,	...	25·0	57·4	30·0	17	9	3·5	33·0	30·5
										36·9	27·0
	β Aquarii	,,	...	...	19·4	47·6	17	23	17·8		
	ϵ Pegasi	,,	37·1	6·7	35·1	3·9	17	37	33·8		
	16 Pegasi	,,	13·2	45·4	16·7	48·1	17	48	20·4		
										At 17h 53m	
										41·3	23·0
	α Gruis	,,	56·0	40·1	21·6	4·0	17	54	47·0	38·2	26·2
										38·5	25·6
	θ Aquarii (?)	E	37·0	7·4	39·0	10·3	18	9	40·9	40·2	24·5
										At 18h 10m	
										43·2	20·2
										50·2	13·9
										50·5	13·5
										44·2	19·4

* This comparison is wrong ; rejected.

From these observations we get the wire intervals—

I.	II.	IV.	V.
s.	s.	s.	s.
57·468	28·137	28·256	57·627

The value of 1 part of the level is $\left\{\begin{matrix} 0''\cdot 832 \\ 0^{s}\cdot 0555 \end{matrix}\right\}$

Reducing these observations, we find that the instrument was not in the meridian. At the time of making the observations Mr. Gill seems not to have understood that the instrument had only recently been moved to its new position, and had not yet been adjusted. Mr. Meldrum made his own observations for time at a temporary observatory about a mile from the New (Royal Alfred) Observatory. The observer states that the collimation was made as nearly zero as possible; but interpolating the level correction according to time, and assuming the chronometer rate $+0^{s}\cdot 43$ per hour, we find (using strict formulæ) by the method of least squares :—

Collimation		Azimuth (α Gruis as pole star)	
s.	s.	s.	s.
−0·346	±0·204	+281·493	±0·056

Whence :—

Date, 1874	Star	Position of lamp	Concluded chronometer time transit over wire III.	Correction for level	Correction for collimation and azimuth	R.A. of star, including daily aberration	Chronometer correction
			h. m. s.	s.	m. s.	h. m. s.	h. m. s.
Aug. 7	61[1] Cygni	W	17 2 34·71	−0·14	−5 4·72	21 1 17·66	+4 3 47·81
	ζ Cygni	„	17 7 57·35	−0·19	−4 8·01	21 7 36·99	47·84
	β Aquarii	„	17 22 19·47	−0·29	−1 8·72	21 24 58·31	47·85
	ε Pegasi	„	17 36 35·26	−0·31	−2 20·37	21 38 2·46	47·88
	16 Pegasi	„	17 47 16·70	−0·30	−3 42·29	21 47 22·26	48·15
	α Gruis	„	17 53 21·66	−0·54	+3 12·00	22 0 21·08	47·96

The last star observed is evidently not θ Aquarii, but may possibly be ρ Aquarii. Assuming, however, that the collimation, as distinctly noted, is not far from zero, there is something wrong in the observation, which we can find no means of rectifying. This forced rejection of the only star observed with the illuminating pivot east diminishes considerably the value of the whole time determination.

Taking the mean, we get therefore—

1874, Aug. 7, at h. 17 m. 26·2, by chronometer 43, correction of chronometer 43 to local sidereal time h. 4 m. 3 s. 47·92*

Using this correction, and assuming the daily rate of chronometer 43 to be $+1^{s}\cdot 975$, we get from the comparisons by coincident beats the corrections of the chronometers compared as follow :—

Date	Rotation No.	Epoch by chronometer	Correction of chronometer to local time	Approximate daily rates
		h. m.	h. m. s.	s.
1874, Aug. 7 . . .	(36)	10 5·9	+3 47 11·66	−1·986
	(37)	10 4·4	3 49 25·04	−0·856
	(41)†	19 3·0	3 58 50·40	−0·911
	(42)	10 5·6	3 49 15·87	−0·016

It was necessary in the first instance to assume rates for these chronometers in order to obtain an approximation to the longitude, and so to get their actual rates between Aden and

* By simply extrapolating the chronometer corrections obtained at Fort George (p. 65), which, according to the late survey, is $16^{s}\cdot 23$ west of Pamplemousses, we obtain the correction of chronometer 43 at the above time $+4^{h}\ 3^{m}\ 47^{s}\cdot 09$.

† Chronometer 41 is regulated to sidereal time.

Mauritius. The improved rates thus obtained will be found on p. 73, together with the small correction, x, which their use introduces into the longitude.

Carrying these corrections and rates back, we get from the daily comparisons, supplying hours and minutes where necessary, the following provisional corrections of chronometer 50 to local mean time:—

Date	By chronometer	Epoch by chronometer 50	Correction of chronometer 50
		h. m.	h. m. s.
1874, Aug. 5	(36)	21 6	+3 53 49·21
	(37)	,,	48·81
	(41)	,,	44·64
	(42)	,,	48·39
	(43)	,,	50·21

Or, rejecting the result by chronometer 41, which at this stage of the reductions seemed to be five seconds in error :—

Aug. 5, at h. 21 m. 6, by chronometer 50, correction to local mean time +3 h. 53 m. 49·15, daily rate +0·636 s.

Using this correction and rate, we find the corrections of all the chronometers to local time as follow.

Comparisons of chronometers with the standard 50 and corrections to local time (hours and minutes supplied where necessary) :—

Rotation No.	1874, August 5			Rotation No.	1874, August 5			
	Time by (50)	Seconds of compared chronometer	Corresponding correction to local time		Time by (50)	Seconds of compared chronometer	Corresponding correction to local time.	
	h. m. s.	s.	h. m. s.		h. m. s.	h. m. s.	h. m. s.	
1	20 13 0	7·6	+3 46 41·53	28	20 49 0	2·55	+3 48 46·59	
2	,,	58·9	3 41 50·23	29	,,	46·2	3 53 2·94	
3	,,	59·8	3 42 49·33	30	20 58 0	24·55	3 32 24·60	
4	,,	52·6	3 43 56·53	31	,,	28·0	3 57 21·15	
7	,,	51·75	3 41 57·38	32	,,	49·25	3 44 59·90	
8	,,	56·25	3 46 52·88	33	,,	40·55	3 51 8·60	
9	,,	40·7	3 46 8·43	34	,,	30·8	3 51 18·35	
10	,,	46·2	3 43 2·93	35	,,	12·0	3 48 37·15	
11	,,	30·8	3 40 18·33	36	21 6 0	34·5	3 47 14·65	
12	20 41 0	55·8	3 50 53·34	37	,,	22·45	3 49 26·70	
13	,,	18·5	3 51 30·64	38	,,	51·0	3 35 58·15	
14	,,	25·65	3 48 23·49	39	,,	23·0	3 36 26·15	
15	,,	2·2	3 50 46·94	40	,,	44·2	3 46 4·95	
16	,,	14·0	3 48 35·14	41†	,,	5 59 49·6	3 58 56·34	
17	,,	5·55	3 40 43·59	42	,,	32·5	3 49 16·65	
18	,,	1·75	3 37 47·39	43†	21 16 41·5	6 5 45·25	4 3 43·94	
19	,,	58·7	3 49 50·44	44	21 15 0	57·0	3 52 52·15	
20	,,	53·5	3 42 55·64	45	,,	7·75	3 57 41·40	
21	20 49 0	54·0	3 46 55·14	46	,,	35·55	3 44 13·60	
22	,,	44·6	3 44 4·54	47	,,	56·8	4 16 52·35	
23	,,	57·7	3 45 51·44	48	,,	35·75	4 4 13·40	
24	,,	8·0	41·44*]	49		48·0	3 49 1·15	
25	,,	20·6	3 48 28·54	50	21 6 0	...	3 53 49·15	
26	,,	12·5	3 58 36·64	51	21 15 0	35·5	3 52 13·65	
27	,,	44·5	[4·64*]	52	,,	53·05	4 6 56·10	

[*] Not used; discordant.

† Chronometers 41 and 43 are regulated to sidereal time.

To utilize these various chronometer corrections according to the principles explained in Chapter I., the first thing required is the temperature for each day, from which to derive the various values of R, the maximum *daily gaining* rate of each chronometer at different stages of the journey. From the daily comparisons (interpolating the corrections for chronometer 50 from three reliable chronometers) we get the following corrections and rates of the chronometrical thermometer, and from these rates the temperature :—

Date, 1874	Time by chronometer 50	Greenwich mean time	Time by chronometrical thermometer	Correction of chronometrical thermometer	*Daily* rate of chronometrical thermometer	Temperature
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	s.	°
June 17	...	0 5 41·9	23 39 0	+0 26 41·9		
					− 30·7	60·3 F.
18	1 15 46·25	1 20 9·6	0 54 0	26 9·6		
					− 14·5	62·9
19	0 8 0	0 12 21·0	23 46 25·2	25 55·8		
					− 13·9	63·0
19	23 17 0	23 21 18·6	22 55 36·2	25 42·4		
					− 14·5	62·9
20	23 20 0	23 24 16·1	22 53 48·2	30* 27·9		
					+ 4·4	65·9
21	23 8 0	23 12 14·1	22 46 41·8	25 32·3		
					+ 17·6	68·0
22	23 27 0	23 31 12·5	23 5 22·3	25 50·2		
					+ 26·6	69·4
23	22 33 0	22 37 11·1	22 10 55·3	26 15·8		
					+ 58·9	74·6
24	22 5 0	22 9 10·1	22 41 56·5	27 13·6		
					+ 34·2	70·7
25	21 58 0	22 2 8·1	21 34 20·5	27 47·6		
					+ 36·3	71·0
26	19 44 0	19 48 6·5	19 19 46·0	28 20·5		
					+ 68·7	76·2
27	20 54 0	20 58 4·7	20 28 33·0	29 31·7		
					+ 80·2	78·0
28	21 5 0	21 9 4·0	20 38 11·5	30 52·5		
					+ 73·7	77·0
29	21 2 0	21 6 2·8	20 33 56·7	32 6·1		
					+ 77·0	77·5
30	18 30 0	18 34 2·1	18 0 47·1	33 15·0		
					+ 85·2	78·8
July 1	20 55 0	20 59 1·5	20 24 12·8	34 48·7		
					+ 82·8	78·5
2	21 2 0	21 6 1·0	20 29 49·1	36 11·9		
					+103·5	81·8
3	20 6 0	20 10 0·4	19 32 9·0	37 51·4		
					+115·6	83·7
4	19 25 0	19 29 0·5	18 49 16·8	39 43·7		
					+106·0	82·2
6	0 41 0	0 43 57·5	0 2 4·5	41 53·0		
					+113·5	83·4
6	21 29 0	21 31 59·8	20 48 28·4	43 31·4		
					+117·3	84·0
7	20 41 0	20 44 2·3	19 58 37·5	45 24·8		
					+118·6	84·2
9	2 44 0	2 47 4·5	1 59 11·2	47 53·3		
					+127·5	85·6
9	20 49 0	20 52 5·8	20 2 36·4	49 29·4		
					+118·9	84·2
10	19 42 0	19 45 7·3	18 53 44·5	51 22·8		
					+128·6	85·8
11	19 49 0	19 52 9·2	18 58 37·2	53 32·0		
					+143·5	88·2
12	20 9 0	20 12 11·3	19 16 13·8	55 57·5		
					+165·7	91·8
13	19 46 0	19 49 13·2	18 50 32·8	0 58 40·5		
					+158·0	90·5
14	19 58 0	20 1 15·0	18 59 55·2	1 1 19·8		
					+131·9	86·3
17	3 26 0	3 29 18·4	2 22 53·8	1 6 24·6		
					+133·7	86·6
18	1 34 0	1 37 19·9	0 28 52·0	1 8 27·9		
					+140·5	87·7
19	1 46 0	1 49 21·6	0 38† 32·0	1 10 49·6		
					+139·8	87·6
20	1 18 0	1 21 23·0	0 8 16·4	1 13 6·6		
					+139·6	87·6
20	23 32 0	23 35 24·7	22 20 8·8	1 15 15·9		
					+149·0	89·1
21	23 42 0	23 45 26·6	22 27 40·7	1 17 45·9		
					+107·7	82·4
22	23 48 0	23 51 27·5	22 31 53·5	1 19 34·0		
					+ 93·0	80·1
24	0 54 0	0 57 28·3	23 36 17·0	1 21 11·3		
					+105·3	82·1
25	1 5 0	1 8 29·1	23 45 31·7	+1 22 57·4		
					+120·1	84·4

* Assumed 25 minutes.

† 18 minutes in original.

Date, 1874	Time by chronometer 50	Greenwich mean time	Time by chronometrical thermometer	Correction of chronometrical thermometer	Daily rate of chronometrical thermometer	Temperature
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	s.	°
July 25	23 56 0	23 59 30·2	22 34 38·5	+1 24 51·7		
26	23 56 0	23 59 31·3	22 32 39·0	1 26 52·3	+120·6	84·5 F.
27	23 35 0	23 38 32·5	22 9 33·9	1 28 58·6	+128·2	85·7
28	23 33 0	23 36 33·4	22 5 43·7	1 30 49·7	+111·1	83·0
30	0 0 0	0 3 33·9	22 31 5·0	1 32 28·9	+ 97·3	80·8
30	23 59 0	0 2 34·3	22 28 35·0	1 33 59·3	+ 90·4	79·7
31	23 46 0	23 49 34·4	22 14 25·1	1 35 9·3	+ 70·6	76·5
Aug. 2	0 26 0	0 29 34·5	22 53 21·7	1 36 12·8	+ 61·8	75·1
3	0 46 0	0 49 34·4	23 12 29·7	1 37 4·7	+ 51·2	73·4
4	1 43 0	1 46 34·0	0 8 43·6	1 37 50·4	+ 43·9	72·2
5	21 3 0	21 6 32·9	19 27 26·1	1 39 6·8	+ 42·3	72·0

With these temperatures, we get the corrections given in the following table to be applied to r, the *actual daily* rate, to obtain R, the *maximum daily gaining* rate, for each of the chronometers for which temperature corrections have been found. (See pp. 29–44.)

Rotation No.	Greenwich to Suez		Suez to Aden		Rotation No.	Greenwich to Suez		Suez to Aden	
	r	Temperature correction	r	Temperature correction		r	Temperature correction	r	Temperature correction
	s.	s.	s.	s.		s.	s.	s.	s.
1	−1·244	−0·223	−0·597	−0·924	28	− 1·082	−0·292	+ 1·160	−1·291
2	−3·770	−0·401	−3·483	−0·057	29*	+ 1·621	...	+ 3·501	...
3	−2·673	−0·111	−2·684	−0·375	30	− 6·556	−0·223	− 6·112	−0·924
4	−2·273	−0·417	−0·961	−1·599	31	+ 2·907	−0·343	+ 4·406	−1·097
7	−4·203	−0·149	−3·056	−0·562	32*	− 2·810	...	− 1·999	...
8	−1·874	−0·158	−1·441	−0·665	33	+ 0·983	−0·385	+ 1·678	−1·606
9	−1·975	−0·217	−1·236	−0·983	34	+ 0·767	−0·125	+ 1·413	−0·528
10	−3·084	−0·108	−2·575	−0·506	35	− 0·511	−0·161	+ 0·276	−0·262
11	−4·408	−0·184	−4·273	−0·379	36	− 1·782	−0·326	− 2·217	−0·093
12	+0·207	−0·267	+1·356	−1·117	37	− 0·779	−0·255	− 0·322	−0·573
13	−0·221	−0·148	+1·600	−0·079	38	− 2·546	−0·238	− 1·584	−0·869
14	−1·246	−0·178	+1·283	−0·779	39	− 4·699	−0·209	− 4·485	−0·873
15	−2·936	−0·222	−1·795	−0·344	40	− 1·739	−0·129	− 0·706	−0·581
16	−1·229	−0·232	+0·296	−1·060	41	− 1·528	−0·260	− 0·602	−1·169
17	−3·687	−0·194	−2·834	−0·860	42	− 0·057	0·000	+ 0·303	0·000
18	−5·226	−0·178	−4·399	−0·735	43	tripped	...	+ 3·159	−1·170
19	+0·658	−0·198	+1·119	−0·624	44	+ 0·224	−0·216	+ 0·698	−0·335
20*	−3·010	...	−3·130	...	45	+ 2·952	−0·240	+ 3·906	−0·784
21*	−0·609	...	−0·097	...	46*	− 4·608	...	− 3·354	...
22	−2·495	−0·715	+0·705	−2·383	47	+11·913	−1·054	+14·058	−2·987
23	−1·823	−0·769	+0·926	−2·363	48	+ 5·969	−0·673	+ 7·791	−2·689
24	−2·175	−0·227	+3·745	−0·256	49	− 1·951	−0·165	− 1·587	−0·685
25	−1·218	−0·870	−1·529	−0·017	50	tripped	...	+ 1·739	−1·223
26	+2·963	−0·542	+4·685	−1·886	51	+ 0·659	−0·224	+ 2·367	−1·029
27	+3·791	−0·262	+9·984	−1·178	52*	+ 0·446	...	+ 1·663	...

* For these chronometers there are no tables for temperature.

To the two sets of values of R thus found, a third can be added from the details of the Rodriguez-Pamplemousses difference of longitude (Chapter III.); we have thus :—

Rotation No.	R			Rotation No.	R		
	Greenwich and Suez	Suez and Aden	Rodriguez and Pamplemousses		Greenwich and Suez	Suez and Aden	Rodriguez and Pamplemousses
	s.	s.	s.		s.	s.	s.
1	−1·467	−1·521	−1·230	28	− 1·374	− 0·131	+0·213
2	−4·171	−3·540	−3·924	29*	+ 1·621	+ 3·501	+0·506
3	−2·784	−3·059	−4·756	30	− 6·779	− 7·036	...
4	−2·690	−2·560	−2·428	31	+ 2·564	+ 3·309	...
7	−4·352	−3·618	−4·418	32*	− 2·810	− 1·999	...
8	−2·032	−2·106	−2·314	33	+ 0·598	+ 0·072	...
9	−2·192	−2·219	−2·646	34	+ 0·642	+ 0·885	...
10	−3·192	−3·081	−3·228	35	− 0·672	+ 0·014	...
11	−4·592	−4·652	−5·945	36	− 2·108	− 2·310	−2·414
12	−0·060	+0·239	+0·227	37	− 1·034	− 0·895	−1·438
13	−0·369	+1·521	−0·294	38	− 2·784	− 2·453	−3·266
14	−1·424	+0·504	−0·658	39	− 4·908	− 5·358	−5·752
15	−3·158	−2·139	−2·806	40	− 1·868	− 1·287	−2·806
16	−1·461	−0·764	−3·132	41	− 1·788	− 1·771	...
17	−3·881	−3·694	−3·523	42	− 0·057	+ 0·303	−0·612
18	−5·404	−5·134	−2·385	43	...	+ 1·989	+1·796
19	+0·460	+0·495	+0·202	44	+ 0·008	+ 0·363	−0·394
20*	−3·010	−3·130	−5·737	45	+ 2·712	+ 3·122	+1·149
21*	−0·609	−0·097	−2·342	46*	− 4·608	− 3·354	−6·673
22	−3·210	−1·678	−1·062	47	+10·859	+11·071	+9·169
23	−2·592	−1·437	−1·660	48	+ 5·296	+ 5·102	...
24	−2·402	+3·489	−3·464	49	− 2·116	− 2·272	−4·702
25	−2·088	−1·546	−3·331	50	...	+ 0·516	...
26	+2·421	+2·779	+2·056	51	+ 0·435	+ 1·338	+1·192
27	+3·529	+8·806	+1·002	52*	+ 0·446	+ 1·663	+0·177

The corrections for temperature for each chronometer for the whole of the run, Aden to Pamplemousses, are :—

Rotation No.	Temperature correction	Rotation No.	Temperature correction	Rotation No.	Temperature correction	Rotation No.	Temperature correction	Rotation No.	Temperature correction
	s.		s.		s.		s.		s.
1	+8·00	13	+0·90	23	+27·86	33	+16·57	43	+11·63
2	1·80	14	6·94	24	2·16	34	4·52	44	2·73
3	2·96	15	2·72	25	4·68	35	2·08	45	6·32
4	17·24	16	9·71	26	21·12	36	1·81	46	...
7	4·69	17	7·66	27	10·89	37	7·62	47	36·14
8	5·76	18	6·32	28	13·00	38	9·54	48	28·20
9	9·33	19	5·08	29	...	39	7·51	49	5·89
10	4·20	20	...	30	7·98	40	5·36	50	12·86
11	2·99	21	...	31	12·75	41	11·24	51	9·44
12	11·51	22	27·19	32	...	42	0·00	52	...

* For these chronometers there are no tables for temperature.

Using, for reasons afterwards stated, the value of R obtained from the run, Suez to Aden, for the interval between Aden and Pamplemousses, with the preceding corrections for temperature, and applying the results to the corrections at Aden (p. 62), we get predicted corrections of each chronometer to Greenwich time, at the time of comparison at Pamplemousses, and bringing over the corresponding corrections on Pamplemousses time (p. 63), we obtain the longitude by each chronometer.

Rotation No.	Calculated chronometer correction to Greenwich time	Chronometer correction to Pamplemousses time	Longitude of Pamplemousses, east of Greenwich	Rotation No.	Calculated chronometer correction to Greenwich time	Chronometer correction to Pamplemousses time	Longitude of Pamplemousses, east of Greenwich
	h. m. s.	h. m. s.	h. m. s.		h. m. s.	h. m. s.	h. m. s.
1	−0 3 37·02	+3 46 41·53	3 50 18·55	28	−0 1 50·86	+3 48 46·59	3 50 37·45
2	−0 8 35·71	3 41 50·23	3 50 25·94	29	+0 3 15·00	3 53 2·94	3 49 47·94
3	−0 7 32·78	3 42 49·33	3 50 22·11	30	−0 17 40·32	3 32 24·60	3 50 4·92
4	−0 6 25·01	3 43 56·53	3 50 21·54	31	+0 7 12·39	3 57 21·15	3 50 8·76
7	−0 8 21·21	3 41 57·38	3 50 18·99	32	−0 4 54·91	3 44 59·90	3 49 54·81
8	−0 3 27·77	3 46 52·88	3 50 20·65	33	+0 1 4·58	3 51 8·60	3 50 4·02
9	−0 4 7·66	3 46 8·43	3 50 16·09	34	+0 0 58·92	3 51 18·35	3 50 19·43
10	−0 7 24·04	3 43 2·93	3 50 26·97	35	−0 1 42·10	3 48 37·15	3 50 19·25
11	−0 9 43·44	3 40 18·33	3 50 1·77	36	−0 3 4·23	3 47 14·65	3 50 18·88
12	+0 0 45·34	3 50 53·34	3 50 8·00	37	−0 0 45·60	3 49 26·70	3 50 12·30
13	+0 1 31·80	3 51 30·64	3 49 58·84	38	−0 14 2·27	3 35 58·15	3 50 0·42
14	−0 2 0·40	3 48 23·49	3 50 23·89	39	−0 14 17·06	3 36 26·15	3 50 43·21
15	−0 0 35·34	3 50 46·94	[3 51 11·60*]	40	−0 4 3·70	3 46 4·95	3 50 8·65
16	−0 1 53·37	3 48 35·14	3 50 28·51	41	+0 8 59·41	3 58 56·34	3 49 56·93
17	−0 9 33·26	3 40 43·59	3 50 16·85	42	−0 0 50·95	3 49 16·65	3 50 7·60
18	−0 12 29·62	3 37 47·39	3 50 17·01	43	+0 13 11·62	4 3 43·94	3 50 32·32
19	−0 0 24·36	3 49 50·44	3 50 14·80	44	+0 2 35·48	3 52 52·15	3 50 16·67
20	−0 7 26·76	3 42 55·64	3 50 22·40	45	+0 7 38·85	3 57 41·40	3 50 2·55
21	−0 3 7·93	3 46 55·14	3 50 3·07	46	−0 5 39·81	3 44 13·60	3 49 53·41
22	−0 6 28·37	3 44 4·54	3 50 32·91	47	+0 26 36·51	4 16 52·35	3 50 15·84
23	−0 4 20·31	3 45 51·44	3 50 11·75	48	+0 14 9·37	4 4 13·40	3 50 4·03
24	...	...	...	49	−0 1 1·91	3 49 1·15	3 50 3·06
25	−0 1 43·39	3 48 28·54	3 50 11·93	50	+0 3 42·92	3 53 49·15	3 50 6·23
26	+0 8 8·38	3 58 36·64	3 50 28·26	51	+0 1 57·01	3 52 13·65	3 50 16·64
27	...	...	...	52	+0 16 45·84	4 6 56·10	3 50 10·26

As a ready, but probably not unfair, method of weighting the individual results, they have been divided into groups, according to the agreement of the three values of R on p. 71.

	s.	s.		h. m. s.	s.
For those whose variation of R is less than	0·5	. .	9 chronometers =	3 50 18·04	±1·17
„ „ „ between	0·5 and	1·0 .	9 „	18·89	+2·81
„ „ „ „	1·0 „	2·0 .	8 „	12·39	±3·05
„ „ „ above	2·0	. .	6 „	19·52	±3·06
„ for which there are not three values of R		.	9 „	10·65	±2·45
„ „ „ no temperature corrections			6 „	1·98	±3·50

Weighting these according to their probable errors, we have :—

	h. m. s.	s.
Pamplemousses east of Greenwich	3 50 15·86 + x	±0·87

[*] Discordant ; rejected ; the chronometer went very wildly on the journey.

where x is the correction to the assumed correction of chronometer 50 to Pamplemousses mean time at the time of comparison with the other chronometers. We obtain x in the following manner.

Using the above difference of longitude, we get the values of R, first of the observing chronometer 43, and then of the four chronometers compared with it, as follows, assuming the temperature at Mauritius to be 72° F. :—

Rotation No.	Correction to Pamplemousses time, Aug. 7	Correction to Greenwich time, Aug. 7	Correction to Greenwich time at Aden, July 18	Interval	Variation	Temperature correction	R	Correction for 72°	Daily rate
	h. m. s.	h. m. s.	h. m. s.	d.	s.	s.	s.	s.	s.
(43)	+4 3 47·92	+0 13 32·06	+0 12 22·81	20·165	+69·25	−11·70	+2·854	+0·05	+2·904
(36)	3 47 11·72	−0 3 4·14	−0 2 23·35	20·018	−40·79	− 2·27	−2·151	+0·30	−1·851
(37)	3 49 25·10	−0 0 50·76	−0 0 36·68	20·018	−14·08	− 7·94	−1·100	+0·21	−0·890
(41)	3 58 50·46	+0 8 34·60	+0 9 20·90	20·074	−46·30	−11·32	−2·870	+0·05	−2·820
(42)	3 49 15·93	−0 0 59·93	−0 0 56·55	20·018	− 3·38	0·00	−0·169	0·00	−0·169

Carrying the corrections back with these improved rates, we get the definitive corrections of chronometer 50 to Pamplemousses time from each of these chronometers :—

Date	By chronometer	Epoch by chronometer 50	Correction of chronometer 50
		h. m.	h. m. s.
1874, Aug. 5	(36)	21 6	+3 53 49·06
	(37)	„	48·92
	(41)	„	47·63
	(42)	„	48·69
	(43)	„	48·85

Weighting these according to the probable errors of the groups in which they fall, we have :—

	h. m.	h. m. s.	s.
At 21 6, by chronometer 50, correction of chronometer 50 to Pamplemousses mean time		+3 53 48·80	±0·22
Assumed chronometer correction		3 53 49·15	

Therefore $x = -0^{s}\cdot35$;

or for the longitude of the central dome of the Royal Alfred Observatory—

	h. m. s.
Pamplemousses east of Greenwich	3 50 15·51

Apart from the uncertainty of the time determinations on arrival at Mauritius, it will be seen that the preceding longitude depends mainly on the adopted values of R. Considering the various vicissitudes to which the chronometers were exposed, it would have been exceedingly valuable to have had these quantities again determined immediately after landing. Amidst the various responsibilities, however, of selecting and preparing a site for the observatories, part of the chronometers ran down, and so interrupted the continuity of their rates. Bearing this interruption in mind, and noting how completely any slight acceleration of the rates between the runs Greenwich to Suez and Rodriguez to Pamplemousses is masked by accidental changes of rate, it was thought safest to adhere solely to the values of R found between Suez and Aden. The resulting predicted times on arrival are therefore completely based on an extrapolation of the rates between the two last-named places, temperature being taken into account.

A very close approximation to an interpolation of the values of R according to *both time and*

temperature, may be obtained by taking the mean of the three values, giving double weight to the middle one, Suez to Aden. This combination gives

	h.	m.	s.
Pamplemousses east of Greenwich	3	50	18·8

Taking into account the difference between this result and the preceding one, the uncertainty of the time determination on arrival, and the fact that it was made thirty-six hours after the last general comparison of chronometers, we have thought it best not to introduce the result of the outward run into the final longitude of the Transit of Venus station at Belmont.

CHAPTER III.

DETERMINATION OF THE DIFFERENCE OF LONGITUDE BETWEEN RODRIGUEZ AND PAMPLEMOUSSES, BY THE TRANSPORT OF CHRONOMETERS.

In the 'Introduction to the Longitudes' it has already been explained how the British Government Transit of Venus Expedition to Rodriguez, in charge of Lieutenant Neate, arranged to co-operate with Mr. Gill in determining the difference of longitude between their station and Pamplemousses. The chronometers were compared and their temperature found from the rate of the chronometrical thermometer in the same way as on the outward journey to Mauritius.

At Rodriguez, Lieutenant Neate and Mr. C. E. Burton observed with a transit instrument mounted on two stone piers, the exact site of which is defined in the Government report of their expedition. Time observations were also made by Lieutenant Hoggan; but as none of them enter essentially into this longitude, and as their use would introduce an extra personal equation, we have preferred to omit them.

At Pamplemousses, Mr. Gill found the time with the Troughton and Simms' altazimuth, mounted on a slab of slate laid across the piers of the transit instrument of the Royal Alfred Observatory.

The operations began by finding the time and comparing the chronometers at Pamplemousses on September 5, 7, and 9, 1874.

On the morning of September 9, civil reckoning, forty-three of the chronometers contained in five of the boxes were carried by coolies from the observatory to the harbour.

At the docks they were received by Captain Wharton and conveyed on board H.M.S. 'Shearwater,' where their gimbals had previously been erected in the chart room, the chart table having been removed for the purpose.

On the night of the 9th, time was again found at Pamplemousses, and transferred on board the 'Shearwater' by means of eight chronometers. The 'Shearwater' sailed from Port Louis for Rodriguez on September 10, at 7 A.M.

The chronometers were intercompared on this and the other runs by Captain Wharton and Lieutenant Langdon. Captain Wharton anchored at Rodriguez on September 13, at 6.30 P.M., and left again September 14, at 8.30 A.M., having been fourteen hours in still water. During the stay Lieutenant Neate and Mr. Burton brought the time on board and compared the chronometers. The interval between the comparisons at Pamplemousses and Rodriguez was about ninety-two hours.

The 'Shearwater' anchored at Bell Buoy, Mauritius, on September 15, at 9 P.M., after a run of thirty-six and a half hours from Rodriguez. At 5 A.M. the next morning Mr. Gill brought six chronometers on board and made the necessary comparisons. Mr. Gill notes, 'The night was cloudy, apparently hopelessly so; I had gone to bed, and was roused about midnight by the

barking of dogs, and found that a carriage had arrived, sent by the harbour master, as previously arranged. It was still cloudy, so there was nothing for it but to compare chronometers, and trust to their rates and the chance of getting observations on the following night. Having finished the comparisons, I found to my great delight that the clouds were clearing off, and I was enabled to make the . . . observations'—for finding the time. The interval between these comparisons and those at Rodriguez was fifty-four hours.

Operations were resumed by a time determination at Pamplemousses on September 18, and the time transferred to the 'Shearwater' by five chronometers. The 'Shearwater' sailed from Rodriguez on September 19, at 5 P.M., and reached Rodriguez on September 23, at 6.30 A.M., the interval between the comparisons at Pamplemousses and Rodriguez being eighty-eight and a half hours.

Captain Wharton left Rodriguez on September 23, at 9.30 A.M., and reached Mauritius on the night of the 24th; Mr. Gill immediately brought time on board. A final comparison of the transfer chronometers at Pamplemousses completed the operations.

We now give the whole of the chronometer comparisons and time observations, with the details of the reductions and the final results.

Comparison of Chronometers at Mauritius.

1874, September 5.

(43)			(36)		
h.	m.	s.	h.	m.	s.
16	19	23·0	5	39	15·0
16	22	25·5	5	42	17·0

(43)			(36)		
h.	m.	s.	h.	m.	s.
17	51	1·0	7	10	38·0
17	57	16·0	7	16	52·0

1874, September 7.

(43)			(36)		
h.	m.	s.	h.	m.	s.
16	50	9·0	6	2	15·0
16	53	15·0	6	5	20·5

(43)			(36)		
h.	m.	s.	h.	m.	s.
18	31	24·0	7	43	13·5
18	34	25·0	7	46	14·0

(43)			(36)		
h.	m.	s.	h.	m.	s.
20	11	11·5	9	22	45·0
20	14	16·0	9	25	49·0

1874, September 9.

At Pamplemousses.

(41)				(30)			
h.	m.	s.			h.	m.	s.
18	58	12·5	}	(30)	7	8	49·0
19	1	16·0	}		7	11	52·0
19	11	28·5	}	(31)	7	26	16·0
19	14	33·0	}		7	29	20·0
19	5	33·5	}	(32)	6	45	16·0
19	8	33·0	}		6	48	15·0
19	18	4·0	}	(33)	6	47	1·0
19	21	9·5	}		6	50	6·0
19	30	20·0	}	(34)	6	50	38·0
19	33	19·5	}		6	53	37·0
19	36	44·0	}	(35)	6	46	45·0
19	39	43·5	}		6	49	44·0
19	24	0·0	}	(50)	8	1	31·0
19	27	2·5	}		8	4	33·0

On board the 'Shearwater.'

(41)				(30)			
h.	m.	s.			h.	m.	s.
22	26	33·0		(30)	10	36	36·0
22	28	49·0		(31)	10	43	3·5
22	32	42·0		(32)	10	11	50·5
22	33	50·0		(33)	11	2	14·5
22	35	36·0		(34)	10	55	23·0
22	40	8·5		(35)	10	49	39·0
22	43	20·0		(50)	11	20	18·0

On board the 'Shearwater.'

(41)			(36)		
h.	m.	s.	h.	m.	s.
22	47	31·0	11	42	35·5
22	50	32·0	11	45	36·0

(36)			(43)		
h.	m.	s.	h.	m.	s.
11	49	0·0	22	45	23·8
11	52	0·0	22	48	34·4

(41)			(36)		
h.	m.	s.	h.	m.	s.
23	28	49·5	12	23	47·0
23	31	54·0	12	26	51·0

1874, SEPTEMBER 13.

At Pamplemousses.

(50) h.	m.	s.		h.	m.	s.
5	56	0·0	(30)	5	29	30·3
6	2	0·0		5	35	30·3
5	55	0·0	(31)	5	32	4·8
6	1	0·0		5	38	4·9
5	54	0·0	(32)	4	56	15·9
6	0	0·0		5	2	16·0
5	57	0·0	(33)	5	48	24·7
6	3	0·0		5	54	24·8
5	59	0·0	(34)	4	41	38·4
6	5	0·0		4	47	38·4
5	58	0·0	(35)	5	30	30·4
6	4	0·0		5	36	30·3
5	42	20·0	(41)	17	20	21·5
6	9	12·0		17	47	18·0

1874, SEPTEMBER 14.

At Pamplemousses.

(50) h.	m.	s.		s.
5	0	0·0	(30)	38·1
	,,			38·1
	,,		(31)	3·5
	,,			3·5
	,		(32)	18·6
	,			18·7
	,		(33)	25·3
	,,			25·4
	,		(34)	36·5
	,			36·4
	,,		(35)	30·2
				30·1
4	57	28·0	(41)	h. m. s.
5	9	29·0		16 39 22·0
				16 51 25·0

1874, SEPTEMBER 15.

At Pamplemousses.

Before observing.

(50) h.	m.	s.		h.	m.	s.
8	42	0·0	(30)	8	15	46·7
	,,					46·8
8	43	0·0	(31)	8	20	1·7
	,,					1·7
8	44	0·0	(32)	8	46	21·6
	,,					21·5
8	40	0·0	(33)	8	32	25·1
	,,					25·2
8	45	0·0	(34)	7	27	34·0
	,,					34·0
8	46	0·0	(35)	8	18	29·7
	,,					29·7
8	35	43·5	(41)	20	22	14·0
8	38	43·0		20	25	14·0
9	2	19·0	(41)	20	48	54·0
9	5	19·5		20	51	55·0

After observing.

(41) h.	m.	s.		h.	m.	s.
21	59	55·0	(30)	9	46	55·5
22	4	48·0	(31)	9	55	4·0
22	2	48·5	(32)	9	18	23·0
22	8	43·0	(33)	10	13	20·0
22	11	15·0	(35)	10	56	56·0
21	57	42·0	(50)	10	10	55·5

On board the 'Shearwater.'

(43)

h.	m.	s.		h.	m.	s.
0	46	35·0	(30)	12	42	4·5
1	43	44·0		13	39	4·5
0	59	13·5	(31)	12	57	54·0
1	57	39·0		13	56	10·0
0	52	36·0	(32)	12	16	38·5
1	48	56·5		13	12	50·0
0	54	5·0	(33)	13	7	10·5
1	52	48·0		14	5	44·0
0	57	10·0	(35)	12	51	19·0
1	55	24·5		13	49	24·0
0	50	25·0	(50)	13	12	5·5
2	1	26·0		14	22	55·0
1	3	29·0	(36)	13	43	22·0
1	6	31·5		13	46	24·0
1	36	55·0	(36)	14	16	43·0
1	40	2·0		14	19	49·0

At Pamplemousses.

(41)

h.	m.	s.		h.	m.	s.
5	4	30·0	(50)	17	16	32·5
5	6	52·0	(35)	16	51	23·5
5	8	20·5	(30)	16	54	12·0
5	11	7·0	(32)	16	25	31·5
5	13	5·0	(33)	17	16	32·0
5	14	37·0	(31)	17	3	39·0
5	17	45·0	(34)	16	12	18·5

1874, SEPTEMBER 18.

At Pamplemousses.

(41)

h.	m.	s.		h.	m.	s.
17	49	36·0	(30)	5	25	42·5
17	54	9·0	(31)	5	33	3·0
17	58	24·0	(32)	5	2	52·5
18	1	27·0		5	5	55·0
17	56	22·0	(33)	5	49	50·5
17	51	48·0	(34)	4	36	12·5
17	46	5·0	(35)	5	20	31·5
17	43	41·0	(50)	5	45	39·0
18	4	35·5		6	6	30·0

(41)

h.	m.	s.		h.	m.	s.
4	2	37·0	(30)	15	37	5·0
4	15	2·0		15	49	28·0
4	26	4·0	(31)	16	3	12·5
4	13	12·0	(32)	15	16	9·0
4	37	34·0		15	40	18·0
4	9	2·0	(33)	16	0	50·0
4	33	26·0		16	25	10·0
4	6	46·5	(34)	14	49	28·0
4	21	35·0		15	4	14·0
3	59	2·0	(35)	15	31	46·5
4	16	58·5		15	49	40·0
3	55	5·0	(50)	15	55	21·5
4	43	2·0		16	43	10·5

On board the 'Shearwater.'

(43)

h.	m.	s.		h.	m.	s.
6	55	34·0	(50)	19	4	33·0
6	57	14·0*	(30)	18	40	26·5
6	58	43·5	(31)	18	44	39·0
7	1	30·0	(32)	18	13	3·0
7	6	16·5	(33)	19	6	48·0
6	53	14·0	(35)	18	34	42·0

(43)

h.	m.	s.
7	9	0·0
7	12	6·0
7	45	27·0
7	48	34·0

(36)

h.	m.	s.
19	36	17·0
19	39	22·5
20	12	38·0
20	15	44·5

1874, SEPTEMBER 19.

On board the 'Shearwater.'

(43)

h.	m.			h.	m.	s.
11	32	0·5	(30)	23	14	32·0
11	30	2·0	31)	23	15	13·0
11	42	4·0	(32)	22	52	52·0
11	45	5·5	(33)	23	44	52·0
11	27	26·5	(35)	23	8	10·0
11	33	23·0	(50)	23	41	37·0
11	36	26·0		23	44	39·5

(43)

h.	m.	s.
11	47	45·0
11	50	50·5
12	24	13·0

(36)

h.	m.	s.
0	14	17·0
0	17	22·0
0	50	39·0

* The seconds in this comparison were transposed in original.

At Pamplemousses.

(41)

h.	m.	s.		h.	m.	s.
14	49	18·5	(50)	2	47	46·0
14	23	7·0	(30)	1	55	55·0
14	29	12·0	(31)	2	4	39·0
14	8	38·0	(32)	1	9	48·0
14	33	2·0		1	34	8·0
14	37	52·0	(33)	2	27	56·0
14	19	56·5	(34)	1	0	55·0
14	43	39·5		1	24	34·0
14	13	6·0	(35)	1	44	8·0
14	46	12·5		2	17	9·0

(41)

h.	m.	s.		h.	m.	s.
19	2	53·0	(30)	6	34	56·0
18	50	9·0	(31)	6	24	52·0
18	47	58·0	(32)	5	48	22·0
18	52	12·0	(33)	6	41	34·0
18	59	9·0	(34)	5	39	20·5
18	55	9·0	(35)	6	25	24·0
18	46	8·0	(50)	6	43	56·0

1874, SEPTEMBER 23.

At Pamplemousses.

(41)

h.	m.	s.		h.	m.	s.
19	53	0·0	(30)	7	9	33·0
20	4	16·0	(31)	7	22	42·5
19	47	23·0	(32)	6	31	52·0
19	58	43·0	(33)	7	31	1·5
20	0	51·5	(34)	6	24	50·0
19	55	46·0	(35)	7	9	55·5
19	48	57·0	(50)	7	30	40·0

1874, SEPTEMBER 24.

At Pamplemousses.

(41)

h.	m.	s.		h.	m.	s.
20	28	9·0	(30)	7	40	46·0
20	45	56·0	(31)	8	0	15·0
20	21	10·0	(32)	6	1	37·5
20	32	44·0	(33)	8	1	59·0
20	38	48·5	(34)	6	58	40·0
20	41	45·0		7	1	36·0
20	30	23·0	(35)	7	40	28·5
20	24	49·5	(50)	8	2	28·0

On board the 'Shearwater.'

(41)

h.	m.	s.		h.	m.	s.
0	1	5·0	(36)	11	56	36·0
0	4	8·5		11	59	39·0
0	51	42·0		12	47	4·5
0	54	47·0		12	50	9·0

(41) (35)

h.	m.	s.		h.	m.	s.
0	57	42·0		12	7	2·5

On board the 'Shearwater.'

(41)

h.	m.	s.		h.	m.	s.
23	38	38·0	(30)	10	50	44·5
23	44	55·0	(31)	10	58	44·0
23	47	46·5	(32)	10	27	40·0
23	51	14·0	(33)	11	19	56·0
23	53	0·0	(34)	10	12	19·0
23	55	57·0		10	15	15·5
23	57	44·5	(35)	11	7	15·0
23	40	46·0	(50)	11	17	52·0

At Pamplemousses.

(41)

h.	m.	s.		h.	m.	s.
5	21	27·0	(30)	16	32	38·5
5	25	45·0	(31)	16	38	37·0
5	28	59·0	(32)	16	7	56·0
5	32	49·5	(33)	17	0	40·0
5	42	20·0	(34)	16	0	40·5
5	45	20·0		16	3	40·0
5	51	48·5	(35)	17	0	20·0
5	38	49·0	(50)	17	14	55·5

Time Determinations at Pamplemousses.

The following observations of time stars in the vertical of a pole star were made with the Troughton and Simms' altazimuth. Observer, Mr. Gill; chronometer 43.

Date, 1874	Pole star	Position of circle	Chronometer time of pole star on wire III.	Level readings	Time star	Chronometer times of transit over wires					Level readings
						I.	II.	III.	IV.	V.	
			h. m. s.	E p. W p.		s.	s.	h. m. s.	s.	s.	E p. W p.
Sept. 5	σ Octantis	E	14 0 53·0	−15·2 +18·9 −22·3 +11·9	η Serpentis	28·3	15·0	14 10 1·4	48·6	35·3	−16·2 +18·2 −21·7 +12·2
	σ Octantis	W	14 22 44·0	−17·1 +16·9 −23·5 +10·5	α Lyræ	12·1	29·4	14 27 46·1	2·8	20·0	−17·2 +16·8 −24·5 +9·9
	σ Octantis	W	15 6 37·0	−14·5 +20·0 −8·5 +26·2	δ Aquilæ	38·7	51·8	15 14 5·5	18·3	31·8	−14·9 +19·4 −8·0 +26·5
	σ Octantis	E	15 24 16·0	−13·1 +21·2 −18·8 +15·5	γ Aquilæ	24·5	11·0	15 34 57·1	44·0	30·9	−13·1 +21·2 −19·8 +14·2
	,,	,,	,,	,, ,,	β Aquilæ	19·9	6·6	15 43 53·0	40·0	26·6	,, ,,
	σ Octantis	W	15 56 16·0	−17·7 +16·6 −11·4 +23·1	β Capricorni	35·6	49·0	16 9 3·5*	16·5	...	−17·0 +17·3 −11·1 +22·5
	σ Octantis	E	18 20 13·0	−14·8 +20·2 −20·2 +14·9	η Aquarii	38·0	25·0	18 23 11·0†	58·5	45·0	−14·5 +20·2 −20·2 +14·5
	,,	,,	,,	,, ,,	ζ Pegasi	26·5	12·8	18 28 59·0	45·5‡	32·3	,, ,,
	σ Octantis	W	18 37 54·0	−22·2 +12·6 −16·2 +18·6	λ Aquarii	15·9	29·3	18 40 43·0	56·1	9·5	−16·2 +18·6 −22·8 +13·1
Sept. 7	σ Octantis	E	18 48 41·0	−18·0 +16·4 −17·0 +17·4	α Pegasi	21·0	7·0	18 51 52·8	39·5	26·2	−17·6 +16·6 −17·6 +16·6
	σ Octantis	W	19 1 12·0	−18·9 +15·8 −18·4 +16·0	γ Piscium	12·5	26·0	19 4 39·4	52·1	5·5	−18·7 +15·6 −19·3 +14·9
	σ Octantis	E	19 10 52·0	−16·3 +18·1 −18·6 +15·5	ι Piscium	44·7	31·2	19 27 17·7	4·7	51·6	−17·6 +16·9 −18·1 +16·3
	,,	,,	,,	,, ,,	δ Sculptoris	28·6	13·6	19 37 58·0	43·0	28·1	−18·0 +16·3 −17·8 +17·0
	σ Octantis	W	19 45 13·0	−20·8 +13·8 −19·1 +15·2	2 Ceti	50·6	4·6	19 52 18·9	32·4	46·3	... ...
	,,	,,	,,	,, ,,	αAndromedæ	...	12·3	19 54 28·0	42·6	57·6	−19·1 +16·6 −20·2 +14·3
	,,	,,	,,	,, ,,	γ Pegasi	40·0	53·6	20 0 7·4	21·3	34·9	,, ,,

Observer, Mr. Gill; chronometer 41.

Sept. 9	σ Octantis	E	17 48 56·0	−18·2 +16·2 −15·5 +18·8	α Aquarii	19·8	6·0	18 1 52·4	39·5	26·4	−18·1 +16·4 −16·2 +18·2
	σ Octantis	W	18 9 50·0	−19·9 +14·5 −17·4 +16·9	θ Aquarii	37·5	51·2	18 13 4·7	17·6	31·4	−18·1 +16·3 −20·1 +14·3

* 16h 8m 58s·5 in original. † 1s·0 in original. ‡ 46s·5 in original.

OBSERVATIONS WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH. OBSERVER, MR. GILL; CHRONOMETER 41—*continued.*

Date, 1874	Pole star	Position of circle	Chronometer time of pole star on wire III.	Level readings	Time star	Chronometer times of transit over wires					Level readings
						I.	II.	III.	IV.	V.	
			h. m. s.	E p. / W p.		s.	s.	h. m. s.	s.	s.	E p. / W p.
Sept. 9	σ Octantis	W	18 9 50·0	−19·9 +14·5 / −17·4 +16·9	γ Aquarii	19·4	32·7	18 17 46·4*	59·3	12·5	−18·1 +16·3 / −20·1 +14·3
	σ Octantis	E	18 25 41·0	−16·2 +18·3 / −16·6 +17·5	η Aquarii	47·7	34·5	18 31 21·0	...	54·4	−16·0 +18·5 / −18·0 +16·5
	,,	,,	,,	,, ,,	ζ Pegasi	36·3†	23·0	18 37 9·8	56·0	42·6	,, ,,
	σ Octantis	W	18 44 23·0	−19·1 +15·4 / −20·2 +14·1	λ Aquarii	26·0	39·4	18 48 53·3	6·2	19·5	−20·0 +14·7 / −18·1 +16·3
	σ Octantis	W	19 52 41·0	+18·0 +16·9 / +18·0 +16·9	ω Piscium	28·4	42·0	19 54 55·5‡	8·5	22·1	... ...
	,,	,,	,,	,, ,,	2 Ceti	7·2	21·4	20 0 35·8	49·3	3·3	... ...
	,,	,,	,,	,, ,,	α Andromedæ	...	29·3	20 2 44·4	59·6	14·5	−17·9 +17·1 / −19·1 +15·6
	,,	,,	,,	,, ,,	γ Pegasi	56·9	10·6	20 8 25·0	38·0	51·7	,, ,,
	σ Octantis	E	20 17 22·0	−15·6 +19·0 / −15·6 +19·4	47 Piscium	21·9	7·6	20 22 54·0§	40·1	26·4	−14·9 +19·8 / −15·5 +19·2
	,,	,,	,,	,, ,,	12 Ceti	36·2	22·8	20 26 9·1	56·3	43·1	,, ,,
Sept. 14	σ Octantis	E	15 52 42·0	−16·1 +18·9 / −15·5 +19·5	θ Aquilæ	29·4	16·0	16 8 2·2	49·4	36·4	−14·9 +20·2 / −16·5 +18·6
	σ Octantis	W	16 15 18·0	−16·5 +18·2 / −19·4 +15·8	β Capricorni	2·0	16·1	16 17 30·0	43·5	57·4	−17·6 +17·8 / −18·8 +16·5
	,,	,,	,,	,, ,,	ρ Capricorni	51·3	5·1	16 25 19·4	...	...	−18·8 +16·4 / −18·0 +17·3
Sept. 15	σ Octantis	W	21 2 12·0	−18·5 +17·4 / −16·7 +19·3	β Andromedæ	...	...	21 3 ...‖	47·0	3·2	... ...
	σ Octantis	E	21 6 42·0	−17·5 +18·2 / −16·0 +19·9	*f* Piscium	18·8	5·4	21 13 52·0	38·5	25·7	−15·2 +20·8 / −17·3 +18·6
	,,	,,	,,	,, ,,	θ Ceti	19·5	6·0	21 20 52·0	39·1	25·8	,, ,,
	σ Octantis	W	21 26 50·0	−19·0 +17·1 / −19·6 +16·2	[α Eridani¶	20·0	44·4	21 40 9·7	34·5	59·5]	−20·4 +15·5 / −16·0 +19·7
	,,	,,	,,	,, ,,	β Arietis	1·6	15·3	21 49 29·4	43·7	57·2	,, ,,
Sept. 18	σ Octantis	W	16 30 44·0	−16·6 +17·6 / −12·5 +21·7	α Delphini	17·1	30·7	16 36 45·0	58·4	12·0	−13·6 +21·0 / −16·6 +17·8
	,,	,,	,,	,, ,,	λ Cygni	13·1	30·0	16 44 46·8	2·5	19·0	,, ,,

* 18^m in original. † $35^s·3$ in original. ‡ 55^m in original. § 23^m in original.
‖ 4^m in original.
[¶] On account of its great declination this star has not been used for clock correction.

OBSERVATIONS WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH. OBSERVER, MR. GILL; CHRONOMETER 41—*cont.*

Date, 1874	Pole star	Position of circle	Chronometer time of pole star on wire III.			Level readings		Time star	Chronometer times of transit over wires					Level readings	
									I.	II.	III.		IV.	V.	
			h.	m.	s.	E p.	W p.		s.	s.	h. m. s.		s.	s.	E p. / W p.
Sept. 18	σ Octantis	W	16	30	44·0	−16·6 −12·5	+17·6 +21·7	32 Vulpeculæ	16·1	31·5	16 51 46·4*		1·2	16·1	−13·6 +21·0 −16·6 +17·8
	σ Octantis	E	16	58	45·0	−14·4 −18·5	+19·9 +15·8	ν Aquarii	48·7	35·0	17 6 21·0		7·3	54·1	... ...
	,,	,,		,,		,,	,,	ι Capricorni	30·9	16·8	17 19 2·8		49·2	35·1	−18·3 +16·1 −14·2 +20·3
	σ Octantis	W	17	25	10·0	−19·7 −15·2	+15·0 +19·3	β Aquarii	54·6	8·1	17 28 22·0		35·0	48·3	−15·0 +19·6 −19·4 +15·1
Sept. 19	σ Octantis	E	17	16	43·0	−14·6 −18·0	+19·5 +16·0	ι Capricorni	34·7	...	17 19 6·7		53·0	39·0	−18·1 +16·1 −14·9 +19·3
	σ Octantis	W	17	26	40·0	−18·4 −15·5	+15·7 +18·8	β Aquarii	...	...	17 28 25·5		38·4	52·0	−14·7 +19·6 −19·2 +15·1
	,,	,,		,,		,,	,,	ξ Aquarii	10·4	24·1	17 34 37·6		51·0	4·0	,, ,,
	σ Octantis	E	17	39	59·0	−18·1 −14·5	+16·2 +19·7	16 Pegasi	56·0	41·4	17 49 26·2		12·0	57·2	−14·5 +20·0 −17·4 +17·0
	,,	,,		,,		,,	,,	α Aquarii	58·0	44·9	18 2 31·1		18·1	5·0	,, ,,
	σ Octantis	W	18	8	4·0	−16·6 −19·0	+18·0 +15·4	θ Aquarii	15·0	28·5	18 13 42·2		55·5	8·9	... ...
	σ Octantis	E	18	26	12·0	−13·9 −17·6	+20·7 +16·9	η Aquarii	25·0	12·0	18 31 58·4		45·2	32·1	−17·4 +17·3 −14·6 +20·0
	,,	,,		,,		,,	,,	ζ Pegasi	13·4	0·0	18 37 46·0		33·1	19·5	,, ,,
Sept. 23	σ Octantis	E	18	46	44·0	−17·5 −13·6	+17·2 +21·2	α Pegasi	29·8	16·1	19 1 2·0		48·7	35·1	−13·2 +21·8 −17·5 +17·4
	σ Octantis	W	19	11	12·0	−13·1 −16·1	+21·8 +18·7	γ Piscium	20·2	33·3	19 13 46·8		0·0	13·0†	−16·0 +19·0 −12·9 +22·0
	σ Octantis	E	19	21	42·0	−16·0 −13·1	+18·8 +21·6	κ Piscium	5·4	...	19 23 38·8‡		25·6	12·1	−13·8 +21·1 −16·3 +18·5
Sept. 24	σ Octantis	W	18	42	12·0	−17·8 −15·3	+17·0 +19·6	μ Pegasi	39·8	54·3	18 46 9·0		23·5	37·8	−17·4 +17·7 −15·5 +19·8
	,,	,,		,,		,,	,,	λ Aquarii	20·8	34·0	18 49 48·0		1·0	14·5	,, ,,
	σ Octantis	E	19	3	54·0	−18·8 −16·3	+16·2 +18·8	κ Piscium	10·5	57·3	19 23 43·8		30·7	17·0	−15·8 +19·7 −18·9 +16·4
	σ Octantis	W	19	32	20·0	−16·1 −18·6	+19·1 +16·8	ι Piscium	5·8	18·9	19 36 32·5		45·6	59·0	−18·9 +16·5 −15·1 +20·0
	σ Octantis	E	19	44	33·0	−19·3 −15·3	+15·7 +19·7	ω Piscium	13·1	59·8	19 55 46·1		33·3	19·7	−15·7 +19·6 −18·9 +16·4
	,,	,,		,,		,,	,,	2 Ceti	55·9	41·8	20 1 27·5		13·6	59·8	,, ,,
	,,	,,		,,		,,	,,	γ Pegasi	42·6	29·0	20 9 15·0		1·5	47·8	−18·0 +17·5 −16·2 +19·0

* 52m in original. † 14h·0 (?) in original. ‡ 21m in original.

OBSERVATIONS WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH. OBSERVER, MR. GILL; CHRONOMETER 41—*cont.*

Date, 1874	Pole star	Position of circle	Chronometer time of pole star on wire III.	Level readings	Time star	Chronometer times of transit over wire					Level readings
						I.	II.	III.	IV.	V.	
			h. m. s.	E p. W p.		s.	s.	h. m. s.	s.	s.	E p. W p.
Sept. 30	σ Octantis	W	17 27 54·0	−16·3 +18·5 −19·0 +16·7	ξ Aquarii	55·6	9·1	17 35 22·4	...	49·1	... ...
	σ Octantis	E	19 33 4·0	−14·9 +20·1 −17·4 +17·6	δ Sculptoris	9·4	54·2	19 47 38·8	24·0	8·4	−14·6 +20·5 −18·2 +17·0
	,,	,,	,,	,, ,,	ω Piscium	42·4	29·0	19 56 15·6	2·7	49·1	−17·8 +17·2 −14·6 +20·3

From the foregoing observations we derive :—

Chronometer 43.

Date	Epoch by chronometer h. m.	Assumed chronometer rate	*c* s.
1874, Sept. 5, 1st group . . .	15 13·3	+0·140 per hour	−1·313
,, ,, 2nd group . . .	18 31·0	,, ,,	−1·182
,, Sept. 7	19 32·7	,, ,,	−1·364

Date, 1874	Star	Position of circle	*C*	Concluded chronometer time of transit over wire III.	R.A. of star, including daily aberration	Rate of chronometer to epoch	(*t* − *m*)	*Cc*	Chronometer correction
				h. m. s.	h. m. s.	s.	m. s.	s.	h. m. s.
Sept. 5 1st group	η Serpentis	E	+1·313	14 10 1·49	18 14 49·52	+0·15	+0 2·69	−1·72	+4 4 49·15
	α Lyræ	W	−2·419	14 27 46·37	18 32 42·08	+0·11	−0 9·81	+3·18	49·19
	δ Aquilæ	,,	−1·412	15 14 5·45	19 19 11·05	0·00	−0 18·65	+1·85	48·80
	γ Aquilæ	E	+1·557	15 34 57·27	19 40 18·49	−0·05	−0 30·08	−2·05	49·04
	β Aquilæ	,,	+1·472	15 43 52·99	19 49 9·87	−0·07	−0 25·98	−1·93	48·90
	β Capricorni	W	−1·130	16 9 3·23	20 13 58·71	−0·13	−0 7·88	+1·48	48·95
Sept. 5 2nd group	η Aquarii	E	+1·351	18 23 11·27	22 28 55·75	+0·02	−0 53·79	−1·60	+4 4 49·11
	ζ Pegasi	,,	+1·558	18 28 58·99	22 35 13·42	0·00	−1 23·22	−1·84	49·37
	λ Aquarii	W	−1·231	18 40 42·99	22 46 5·35	−0·02	−0 34·54	+1·46	49·26
Sept. 7	α Pegasi	E	+1·655	18 51 53·07	22 58 31·87	+0·10	−1 40·69	−2·26	+4 4 55·95
	γ Piscium	W	−1·411	19 4 39·33	23 10 40·86	+0·07	−1 7·17	+1·93	56·36
	ι Piscium	E	+1·455	19 27 17·75	23 33 31·04	+0·01	−1 15·09	−1·98	56·23
	δ Sculptoris	,,	+0·958	19 37 58·00	23 42 24·97	−0·01	+0 30·76	−1·31	56·41
	2 Ceti	W	−1·092	19 52 18·80	23 57 20·12	−0·05	−0 6·28	+1·49	56·48
	α Andromedæ	,,	−2·041	19 54 27·84	0 1 55·37	−0·05	−2 34·32	+2·78	55·94
	γ Pegasi	,,	−1·656	20 0 7·67	0 6 47·68	−0·06	−1 46·10	+2·26	56·11

Chronometer 41.

Date	Epoch by chronometer h. m.	Assumed chronometer rate s.	*c* s.
1874, Sept. 9, 1st group . . .	18 25·0	−0·146 per hour	−1·271
,, ,, 2nd group . . .	20 9·3	,, ,,	−1·420
,, ,, 14	16 16·9	,, ,,	−1·343
,, ,, 15	21 22·0	−0·175 ,,	−1·502
,, ,, 18	17 1·2	−0·163 ,,	−1·569
,, ,, 19	17 57·2	−0·160 ,,	−1·382
,, ,, 23	19 12·8	−0·143 ,,	−1·467
,, ,, 24	19 31·8	−0·140 ,,	−1·510
,, ,, 30	19 6·4	−0·196 ,,	−1·123

OBSERVATIONS WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH. OBSERVER, MR. GILL; CHRONOMETER 41—*continued.*

Date, 1874	Star	Position of circle	C	Concluded chronometer time of transit over wire III.			R.A. of star, including daily aberration			Rate of chronometer to epoch	$(t-m)$		Cc	Chronometer correction		
				h.	m.	s.	h.	m.	s.	s.	m.	s.	s.	h.	m.	s.
Sept. 9	α Aquarii	E	+1·347	18	1	52·59	21	59	21·53	−0·06	−0	47·88	−1·71	+3	56	39·29
1st group	θ Aquarii	W	−1·228	18	13	4·71	22	10	14·02	−0·03	−0	31·39	+1·56			39·45
	γ Aquarii	,,	−1·329	18	17	46·29	22	15	11·72	−0·02	−0	47·79	+1·69			39·31
	η Aquarii	E	+1·351	18	31	20·86	22	28	55·76	+0·02	−0	53·58	−1·72			39·62
	ζ Pegasi	,,	+1·558	18	37	9·31	22	35	13·43	+0·03	−1	22·82	−1·98			39·35
	λ Aquarii	W	−1·230	18	48	53·11	22	46	5·37	+0·06	−0	34·38	+1·56			39·50
Sept. 9	ω Piscium	W	−1·479	19	54	55·53	23	52	53·34	−0·03	−1	20·80	+2·10	+3	56	39·08
2nd group	2 Ceti	,,	−1·092	20	0	35·64	23	57	20·15	−0·02	−0	6·76	+1·55			39·28
	α Andromedæ	,,	−2·042	20	2	44·66	0	1	55·39	−0·02	−2	34·60	+2·90			39·01
	γ Pegasi	,,	−1·656	20	8	24·67	0	6	47·70	0·00	−1	46·41	+2·35			38·97
	47 Piscium	E	+1·722	20	22	53·76	0	21	31·74	+0·03	−1	56·45	−2·45			39·11
	12 Ceti	,,	+1·288	20	26	9·27	0	23	39·34	+0·04	−0	49·31	−1·83			38·97
Sept. 14	θ Aquilæ	E	+1·341	16	8	2·45	20	4	50·68	−0·02	−0	24·11	−1·80	+3	56	22·30
	β Capricorni	W	−1·130	16	17	30·03	20	13	58·62	0·00	−0	7·82	+1·52			22·29
	ρ Capricorni	,,	−1·089	16	25	19·43	20	21	43·18	+0·02	−0	2·92	+1·46			22·31
Sept. 15	β Andromedæ	W	−2·290	21	3	31·17	1	2	43·81	−0·05	−2	59·56	+3·44	+3	56	16·47
	f Piscium	E	+1·420	21	13	51·85	1	11	20·81	−0·02	−1	10·39	−2·13			16·42
	θ Ceti	,,	+1·223	21	20	52·25	1	17	46·37	0·00	−0	35·65	−1·84			16·63
	β Arietis	W	−1·803	21	49	29·68	1	47	43·64	+0·08	−2	0·16	+2·71			16·59
Sept. 18	α Delphini	W	−1·671	16	36	44·88	20	33	49·49	−0·07	−1	0·74	+2·62	+3	56	6·42
	λ Cygni	,,	−2·308	16	44	46·56	20	42	32·20	−0·04	−1	42·96	+3·62			6·26
	32 Vulpeculæ	,,	−2·002	16	51	46·51	20	49	13·67	−0·03	−1	23·76	+3·14			6·51
	ν Aquarii	E	+1·176	17	6	20·99	21	2	46·62	+0·01	−0	17·36	−1·84			6·44
	ι Capricorni	,,	+1·101	17	19	2·72	21	15	16·76	+0·05	−0	6·07	−1·73			6·29
	β Aquarii	W	−1·263	17	28	21·83	21	24	58·31	+0·07	−0	32·32	+1·98			6·21
Sept. 19	ι Capricorni	E	+1·101	17	19	6·61	21	15	16·76	−0·10	−0	6·55	−1·52	+3	56	1·98
	β Aquarii	W	−1·263	17	28	25·48	21	24	58·30	−0·08	−0	32·57	+1·75			1·92
	ξ Aquarii	,,	−1·227	17	34	37·65	21	31	5·46	−0·06	−0	27·45	+1·70			2·00
	16 Pegasi	E	+1·936	17	49	26·31	21	47	22·30	−0·02	−1	51·38	−2·68			1·91
	α Aquarii	,,	+1·347	18	2	31·19	21	59	21·51	+0·01	−0	46·53	−1·86			1·94
	θ Aquarii	W	−1·228	18	13	42·25	22	10	14·01	+0·04	−0	31·45	+1·70			2·05
	η Aquarii	E	+1·351	18	31	58·31	22	28	55·77	+0·09	−0	53·78	−1·87			1·90
	ζ Pegasi	,,	+1·558	18	37	46·17	22	35	13·45	+0·11	−1	23·04	−2·15			2·20
Sept. 23	α Pegasi	E	+1·655	19	1	2·11	22	58	31·91	−0·03	−1	39·35	−2·43	+3	55	47·99
	γ Piscium	W	−1·411	19	13	46·89	23	10	40·93	0·00	−1	8·28	+2·07			47·83
	κ Piscium	E	+1·375	19	23	38·59	23	20	31·35	+0·03	−1	3·16	−2·02			47·61
Sept. 24	μ Pegasi	W	−1·898	18	46	9·13	22	43	58·06	−0·11	−2	7·26	+2·87	+3	55	44·43
	λ Aquarii	,,	−1·231	18	49	47·89	22	46	5·40	−0·10	−0	34·88	+1·86			44·39
	κ Piscium	E	+1·375	19	23	43·51	23	20	31·36	−0·02	−1	1·21	−2·08			44·54
	ι Piscium	W	−1·455	19	36	32·59	23	33	31·15	+0·01	−1	16·24	+2·20			44·53
	ω Piscium	E	+1·479	19	55	46·17	23	52	53·47	+0·06	−1	20·58	−2·23			44·55
	2 Ceti	,,	+1·092	20	1	27·48	23	57	20·28	+0·07	−0	6·90	−1·65			44·32
	γ Pegasi	,,	+1·656	20	9	14·95	0	6	47·85	+0·09	−1	46·13	−2·50			44·36
Sept. 30	ξ Aquarii	W	−1·227	17	35	22·63	21	31	5·37	−0·30	−0	27·49	+1·38	+3	55	16·33
	δ Sculptoris	E	+0·958	19	47	38·70	23	42	25·12	+0·13	+0	30·77	−1·08			16·24
	ω Piscium	,,	+1·479	19	56	15·53	23	52	53·49	+0·16	−1	20·09	−1·66			16·37

The means of the separate groups then give the following chronometer corrections :—

Chronometer 43.

Date	Epoch by chronometer	Chronometer correction to local sidereal time		Adopted chronometer rate
	h. m.	h. m. s.	h. m. s.	s.
1874, Sept. 5, 1st group . .	15 13·3	Circle E +4 4 49·030 „ W 48·980	+4 4 49·01	+0·1397 per hour.
„ Sept. 5, 2nd group . .	18 31·0	Circle E +4 4 49·240 „ W 49·260	+4 4 49·25	
„ Sept. 7	19 32·7	Circle E +4 4 56·197 „ W 56·222	+4 4 56·21	+0·1397 „

Chronometer 41.

Date	Epoch by chronometer	Chronometer correction to local sidereal time		Adopted chronometer rate
	h. m.	h. m. s.	h. m. s.	s.
1874, Sept. 9, 1st group . .	18 25·0	Circle E +3 56 39·420 „ W 39·420	+3 56 39·42	−0·1448 per hour.
„ Sept. 9, 2nd group . .	20 9·3	Circle E +3 56 39·085 „ W 39·040	+3 56 39·06	
„ Sept. 14	16 16·9	Circle E +3 56 22·300 „ W 22·300	+3 56 22·30	−0·1716 „
„ Sept. 15	21 22·0	Circle E +3 56 16·525 „ W 16·530	+3 56 16·53	−0·1714 „
„ Sept. 18	17 1·2	Circle E +3 56 6·365 „ W 6·350	+3 56 6·36	−0·1628 „
„ Sept. 19	17 57·2	Circle E +3 56 1·986 „ W 1·990	+3 56 1·99	−0·1603 „
„ Sept. 23	19 12·8	Circle E +3 55 47·800 „ W 47·830	+3 55 47·815	−0·1420 „
„ Sept. 24	19 31·8	Circle E +3 55 44·442 „ W 44·450	+3 55 44·45	−0·1672 „
„ Sept. 30	19 6·4	Circle E +3 55 16·305 „ W 16·330	+3 55 16·32	... „

Using these corrections and rates of the observing chronometers, we obtain from the comparisons the following corrections to local mean time for the chronometers retained at Mauritius :—

Date, 1874	Rotation Number							
	(30)		(31)		(32)		(33)	
	Epoch by (30)	Chronometer correction	Epoch by (31)	Chronometer correction	Epoch by (32)	Chronometer correction	Epoch by (33)	Chronometer correction
	h. m.	h. m. s.	h. m.	h. m. s.	h. m.	h. m. s.	h. m.	h. m. s.
Sept. 7	6 15·7	+4 31 34·95	6 19·2	+4 27 2·10	5 44·0	+5 2 17·05	6 33·3	+4 12 56·15
9	7 10·3	17·94	7 27·8	4·73	6 46·8	10·72	7 48·6	54·13
14	4 36·8	30 36·55	4 40·0	11·15	4 5·4	1 56·00	4 54·4	49·30
15	...	...	8 20·0	[11·59*]	...	...	...	...
15	9 46·9	+4 30 25·93	9 55·1	[9·62*]	9 18·4	+5 1 51·44	10 13·3	+4 12 47·96
18	5 25·7	3·05	5 33·0	14·80	5 4·4	39·58	5 49·8	39·92
19	6 34·9	29 54·22	6 24·9	16·35	5 48·4	35·71	6 41·6	37·00
23	7 9·6	18·34	7 22·7	22·96	6 31·9	23·26	7 32·0	31·89
24	7 40·8	9·25	8 0·2	24·29	7 1·6	19·92	8 2·0	30·49

[*] These comparisons being doubtful, this chronometer has not been used on the 15th.

Date, 1874	Rotation Number					
	(34)		(35)		(50)	
	Epoch by (34)	Chronometer correction	Epoch by (35)	Chronometer correction	Epoch by (50)	Chronometer correction
	h. m.	h. m. s.	h. m.	h. m. s.	h. m.	h. m. s.
Sept. 7	5 24·8	+5 21 27·95	6 14·5	+4 31 48·05	6 41·9	+4 4 21·15
9	6 52·1	31·11	7 48·2	47·04	8 3·0	19·15
14	3 45·6	38·20	4 35·5	44·50	5 3·5	14·645
15	7 27·6	39·29	9 56·9	43·54	9 17·3	13·26
18	4 36·2	44·68	5 20·5	43·64	5 56·2	12·545
19	5 39·3	46·35	6 25·4	43·51	6 43·9	12·02
23	6 24·8	51·53	7 9·9	41·37	7 30·7	9·01
24	7 0·1	52·99	7 40·5	40·89	8 2·5	8·31

From the foregoing corrections we have adopted the following rat s for the days on which time was taken to H.M.S. 'Shearwater' on its departure for and arrival from Rodriguez :—

Date, 1874	Adopted *hourly* rates of Chronometers retained at Mauritius						
	(30)	(31)	(32)	(33)	(34)	(35)	(50)
	s.	s.	s.	s.	s.	s.	s.
Sept. 9	−0·3500	+0·0542	−0·1272	−0·0411	+0·0622	−0·0211	−0·0395
15	−0·3512	...	−0·1656	−0·0823	+0·0587	−0·0156	−0·0298
18–19	−0·3511	+0·0623	−0·1565	−0·1175	+0·0666	−0·0052	−0·0212
24	−0·3707	+0·0541	−0·1363	−0·0571	+0·0594	−0·0212	−0·0286

Carrying Time on board H.M.S. 'Shearwater.'

1874, *September* 9.—The intercomparisons between the eight chronometers used to carry on the time at Mauritius, and the main body of the chronometers on board the 'Shearwater,' were effected by the mean-time chronometer 36, a sidereal chronometer being interposed to obtain the advantage of coincident beats in the comparisons with the smaller group. It may be well to point out that (36) and the sidereal chronometer 43 were retained on board the 'Shearwater.'

In this way we have :—

	h.	m.						h.	m.	s.
By chronometer 30 at	22	26·6	by (41),	correction for (41)	to	Pamplemousses	sidereal time	+3	56	38·71
„ 31 „	22	28·8	„	„	„	„	„			38·75
„ 32 „	22	32·7	„	„	„	„	„			38·77
„ 33 „	22	33·8	„	„	„	„	„			38·66
„ 34 „	22	35·6	„	„	„	„	„			38·75
„ 35 „	22	40·1	„	„	„	„	„			38·68
„ 50 „	22	43·3	„	„	„	„	„			38·74
By its own rate „	22	34·4	„	„	„	„	„			38·76

	h.	m.						h.	m.	s.	Adopted *hourly* rate s.
Or at	22	34·4	by chronometer 41,	correction for (41)	to	Pamplemousses	sidereal time	−3	55	38·73	−0·1448

And from the comparisons of (41) with (36), and (36) with (43) :—

			Adopted *hourly* rate
h. m.		h. m. s.	s.
At 12 4·7	by chronometer 36, correction for (36) to Pamplemousses mean time	+3 46 11·815	−0·0894
At 22 47·1	by chronometer 43, correction for (43) to Pamplemousses sidereal time	+4 5 1·44	...

September 15.—From the comparisons with the Mauritius chronometers we get the following corrections for chronometer 43 :—

Before Comparisons			After Comparisons		
By chronometer	Time by chronometer 43	Correction of (43) to Pamplemousses sidereal time	By chronometer	Time by chronometer 43	Correction of (43) to Pamplemousses sidereal time
	h. m.	h. m. s.		h. m.	h. m. s.
30	0 46·6	+4 5 13·16	30	1 43·7	+4 5 13·19
32	0 52·6	13·20	32	1 48·9	13·27
33	0 54·1	13·21	33	1 52·8	13·25
35	0 57·2	12·98	35	1 55·4	13·02
50	0 50·4	13·03	50	2 1·4	13·13

			Adopted *hourly* rate
h. m.		h. m. s.	s.
Or at 1 22·3	by chronometer 43, correction of (43) to Pamplemousses sidereal time	+4 5 13·14	+0·0558

And from the comparisons of chronometers 43 and 36 :—

			Adopted *hourly* rate
h. m.		h. m. s.	s.
At 14 1·6	by chronometer 36, correction of (36) to Pamplemousses mean time	+3 45 58·625	+0·0900

September 18–19.—In the same way as on September 15, we obtain the corrections for chronometers 43 and 36 :—

By chronometer	Epoch by chronometer 43	Correction of (43) to Pamplemousses sidereal time	By chronometer	Epoch by chronometer 43	Correction of (43) to Pamplemousses sidereal time
	h. m.	h. m. s.		h. m.	h. m. s.
30	6 57·2	+4 5 18·12	30	11 32·0	[+4 5 20·55*]
31	6 58·7	18·59	31	11 30·0	+4 5 18·82
32	7 1·5	18·44	32	11 42·1	18·68
33	7 6·3	18·56	33	11 45·1	18·69
35	6 53·2	18·13	35	11 27·4	18·54
50	6 55·6	18·22	50	11 34·9	18·64

				Adopted *hourly* rate
h. m.		h. m. s.		s.
Or at 6 58·8	by chronometer 43, correction of (43) to Pamplemousses sidereal time	+4 5 18·34	}	+0·0716
and at 11 35·9	by chronometer 43, correction of (43) to Pamplemousses sidereal time	18·67	}	

And

			Adopted *hourly* rate
h. m.		h. m. s.	s.
at 19 56·0	by chronometer 36, correction of (36) to Pamplemousses mean time	+3 45 52·24	+0·0989
at 0 33·2	by chronometer 36, correction of (36) to Pamplemousses mean time	51·90	+0·1033

[*] Discordant ; rejected.

September 24.—Carrying on the time by means of the Mauritius chronometers, we get from the comparisons the following corrections of chronometer 41 :—

	h.	m.						h.	m.	s.
By chronometer 30 at	23	38·6	by (41),	correction of (41)	to	Pamplemousses	sidereal time	+3	55	43·82
„ 31 „	23	44·9	„	„	„	„	„			43·72
„ 32 „	23	47·8	„	„	„	„	„			43·69
„ 33 „	23	51·2	„	„	„	„	„			43·61
„ 34 „	23	54·5	„	„	„	„	„			43·77
„ 35 „	23	57·7	„	„	„	„	„			43·69
„ 50 „	23	40·8	„	„	„	„	„			43·81
By its own rate „	23	47·9	„	„	„	„	„			43·74

h.	m.						h.	m.	s.
Or at 23	47·9	by chronometer 41,	correction of (41)	to	Pamplemousses	sidereal time	+3	55	43·73

And from a final comparison with chronometer 35 we get—

	h.	m.						h.	m.	s.
By chronometer 35 at	o	57·7	by 41,	correction of (41)	to	Pamplemousses	sidereal time	+3	55	43·50
By its own rate at	o	57·7	by 41,	correction of (41)	to	Pamplemousses	sidereal time			43·54

h.	m.						h.	m.	s.	Adopted *hourly* rate s.
Or at o	57·7	by chronometer 41,	correction of (41)	to	Pamplemousses	sidereal time	+3	55	43·52	−0·1806

And from the comparison of chronometer 41 with chronometer 36, and chronometer 36 with chronometer 43, we get :—

h.	m.						h.	m.	s.	Adopted *hourly* rate s.
At 12	23·4	by chronometer 36,	correction of (36)	to	Pamplemousses	mean time	+3	45	39·795	+0·0594

And—

h.	m.						h.	m.	s.
At o	24·8	by chronometer 43,	correction of (43)	to	Pamplemousses	sidereal time	+4	5	29·11

We are now in a position to determine the corrections of the chronometers sent to Rodriguez at the times of their departure from and return to Mauritius.

COMPARISONS OF CHRONOMETERS SENT TO RODRIGUEZ WITH THE STANDARD (36).

Rotation No.	1874, SEPT. 9		1874, SEPT. 15		1874, SEPT. 18		1874, SEPT. 19		1874, SEPT. 24	
	Time by (36)	Seconds of compared chronometer	Time by (36)	Seconds of compared chronometer	Time by (36)	Seconds of compared chronometer	Time by (36)	Seconds of compared chronometer	Time by (36)	Seconds of compared chronometer
	h. m. s.	s.	h. m. s.	s.	h. m. s.	s.	h. m. s.	s.	h. m. s.	s.
1	12 4 0	24·6	14 0 0	18·4	19 53 0	16·05	0 28 0	15·95	12 11 0	10·8
2	,,	31·4	,,	40·0	,,	46·1	,,	46·6	,,	55·0
3	,,	34·35	,,	49·35	,,	57·45	,,	58·0	,,	12·5
4	,,	28·05	,,	27·2	,,	27·6	,,	27·75	,,	28·1
7	,,	51·65	,,	3·7	,,	11·0	,,	11·5	,,	25·0
8	,,	39·4	,,	39·3	,,	39·6	,,	39·75	,,	41·05
9	,,	25·75	,,	28·05	,,	30·25	,,	30·4	,,	32·6
10	,,	57·5	,,	1·65	,,	4·2	,,	4·6	,,	12·15
11	,,	18·85	,,	41·1	,,	52·95	,,	53·6	,,	14·5
12	12 12 0	26·5	14 7 0	10·35	20 0 0	3·2	0 31 0	2·6	12 17 0	49·2
13	,,	56·5	,,	44·0	,,	38·55	,,	38·2	,,	28·0
14	,,	21·25	,,	11·0	,,	7·0	,,	6·8	,,	59·0
15	,,	39·1	,,	42·05	,,	44·5	,,	44·6	,,	48·25
16	,,	25·8	,,	30·35	,,	35·5	,,	35·85	,,	41·5
17	,,	24·5	,,	28·0	,,	33·35	,,	33·75	,,	45·0
18	,,	20·55	,,	21·3	,,	21·6	,,	21·6	,,	23·0
19	,,	13·95	,,	59·0	,,	50·3	,,	49·9	,,	37·05
20	,,	56·55	,,	17·0	,,	30·5	,,	31·3	,,	51·8
21	12 20 0	34·5	14 14 0	33·4	20 5 0	34·55	0 35 0	34·85	12 22 0	37·5
22	,,	43·45	,,	32·6	,,	28·1	,,	27·75	,,	19·3
23	,,	36·8	,,	29·9	,,	30·05	,,	30·0	,,	23·55
24	,,	34·5	,,	40·65	,,	46·0	,,	46·45	,,	54·1
25	,,	3·6	,,	6·0	,,	7·55	,,	7·6	,,	10·7
26	,,	39·2	,,	10·1	,,	55·9	,,	55·35	,,	30·6
27	,,	10·1	,,	48·5	,,	38·35	,,	37·5	,,	21·55
28	,,	21·5	,,	6·3	,,	59·5	,,	59·0	,,	44·9
29	,,	43·6	,,	26·5	,,	16·5	,,	16·0	,,	1·95
37	11 47 0	30·55	13 50 0	24·35	19 44 0	22·4	0 20 0	22·35	12 27 0	17·1
38	,,	16·55	,,	22·05	,,	26·0	,,	26·1	,,	31·3
39	,,	5·7	,,	24·55	,,	37·1	,,	38·0	,,	0·0
40	,,	36·6	,,	38·55	,,	41·05	,,	41·15	,,	46·0
42	,,	57·0	,,	46·65	,,	42·3	,,	42·0	,,	34·1
44	11 56 0	21·0	13 58 0	7·0	19 49 0	2·4	0 24 0	2·05	12 34 0	54·55
45	,,	42·35	,,	21·95	,,	11·45	,,	10·8	,,	52·5
46	,,	50·1	,,	13·0	,,	30·35	,,	31·1	,,	0·0
47	,,	28·15	,,	11·8	,,	33·95	,,	31·5	,,	25·85
48	,,	25·15	,,	5·4	,,	48·75	,,	47·05	,,	10·05
49	,,	25·6	,,	36·4	,,	47·4	,,	47·85	,,	5·8
51	,,	1·0	,,	36·8	,,	27·4	,,	27·0	,,	11·1
52	,,	33·9	,,	17·4	,,	11·3	,,	10·9	,,	59·9
A	...	...	...	...	20 23 0	50·65	0 41 0	50·5	12 40 0	43·05
B	...	...	...	...	,,	45·0	,,	44·4	,,	24·15
D	...	...	...	...	,,	20·5	,,	20·8	,,	30·45
F	...	...	...	...	,,	58·0	,,	56·9	,,	24·5
G	...	...	...	...	,,	40·45	,,	41·1	,,	54·6
H	...	...	...	...	...	...	0 43 0	57·65	,,	16·05

The resulting corrections of the chronometers to local mean time (supplying the hours and minutes) are then :—

Rotation No.	1874, Sept. 9	1874, Sept. 15	1874, Sept. 18	1874, Sept. 19	1874 Sept. 24
	Chronometer correction	Chronometer correction	Chronometer correction	Chronometer correction	Chronometer correction
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	+3 45 47·22	+3 45 40·22	+3 45 36·19	+3 45 35·94	+3 45 28·98
2	3 39 40·42	3 39 18·62	3 39 6·14	3 39 5·29	3 38 44·78
3	3 40 37·47	3 40 9·27	3 39 54·79	3 39 53·89	3 39 27·28
4	3 42 43·77	3 42 31·42	3 42 24·64	3 42 24·14	3 42 11·68
7	3 39 20·17	3 38 54·92	3 38 41·24	3 38 40·39	3 38 14·78
8	3 45 32·42	3 45 19·32	3 45 12·64	3 45 12·14	3 44 58·73
9	3 44 46·07	3 44 30·57	3 44 21·99	3 44 21·49	3 44 7·18
10	3 41 14·32	3 40 56·97	3 40 48·04	3 40 47·29	3 40 27·63
11	3 36 52·97	3 36 17·52	3 35 59·29	3 35 58·29	3 35 25·28
12	3 50 45·30	3 50 48·28	3 50 49·05	3 50 49·30	3 50 50·29
13	3 51 15·30	3 51 14·63	3 51 13·70	3 51 13·70	3 51 11·79
14	3 47 50·55	3 47 47·63	3 47 45·25	3 47 45·10	3 47 40·79
15	3 50 32·70	3 50 16·58	3 50 7·75	3 50 7·30	3 49 51·54
16	3 47 46·00	3 47 28·28	3 47 16·75	3 47 16·05	3 46 58·29
17	3 38 47·30	3 38 30·63	3 38 18·90	3 38 18·15	3 37 54·79
18	3 35 51·25	3 35 37·33	3 35 30·65	3 35 30·30	3 35 16·79
19	3 49 57·85	3 49 59·63	3 50 1·95	3 50 2·00	3 50 2·74
20	3 40 15·25	3 39 41·63	3 39 21·75	3 39 20·60	3 38 47·99
21	3 45 37·29	3 45 25·24	3 45 17·70	3 45 17·05	3 45 2·29
22	3 43 28·34	3 43 26·04	3 43 24·15	3 43 24·15	3 43 20·49
23	3 44 34·99	3 44 28·74	3 44 22·20	3 44 21·90	3 44 16·24
24	3 44 37·29	3 44 17·99	3 44 6·25	3 44 5·45	3 43 45·69
25	3 47 8·19	3 46 52·64	3 46 44·70	3 46 44·30	3 46 29·09
26	4 0 32·59	4 0 48·54	4 0 56·35	4 0 56·55	4 1 9·19
27	4 0 1·69	4 0 10·14	4 0 13·90	4 0 14·40	4 0 18·24
28	3 48 50·29	3 48 52·34	3 48 52·75	3 48 52·90	3 48 54·89
29	3 53 28·19	3 53 32·14	3 53 35·75	3 53 35·90	3 53 37·84
37	3 48 41·29	3 48 34·26	3 48 29·82	3 48 29·53	3 48 22·70
38	3 33 55·29	3 33 36·56	3 33 26·22	3 33 25·78	3 33 8·50
39	3 31 6·14	3 30 34·06	3 30 15·12	3 30 13·88	3 29 39·80
40	3 44 35·24	3 44 20·06	3 44 11·17	3 44 10·73	3 43 53·80
42	3 49 14·84	3 49 11·96	3 49 9·92	3 49 9·88	3 49 5·70
44	3 52 50·83	3 52 51·62	3 52 49·83	3 52 49·83	3 52 45·26
45	3 58 29·48	3 58 36·67	3 58 40·78	3 58 41·08	3 58 47·31
46	3 40 21·73	3 39 45·62	3 39 21·88	3 39 20·78	3 38 39·81
47	4 22 43·68	4 23 46·82	4 24 18·28	4 24 20·38	4 25 13·96
48	4 5 46·68	4 6 53·22	4 7 3·48	4 7 4·83	4 7 29·76
49	3 46 46·23	3 46 22·22	3 46 4·83	3 46 4·03	3 45 34·01
51	3 52 10·83	3 52 21·82	3 52 24·83	3 52 24·88	3 52 28·71
52	4 7 37·93	4 7 41·22	4 7 40·93	4 7 40·98	4 7 39·91
A	...	...	1 38 1·63	1 38 1·41	1 37 56·76
B	...	...	6 14 7·28	6 14 7·51	6 14 15·66
D	...	...	2 44 31·78	2 44 31·11	2 44 9·36
F	...	...	10 46 54·28	10 46 55·01	10 47 15·31
G	...	...	3 42 11·83	3 42 10·81	3 41 45·21
H	...	...	...	3 57 54·27	3 58 23·76

These numbers yield the mean rates of all the chronometers carried to and from Rodriguez excepting (36) and (43), for which, however, corrections have already been derived. The comparisons on the 18th and 19th being in reality only $4\frac{1}{2}$ hours asunder, a mean of the results was taken. The succeeding table shows the separate rates for each interval :—

Rotation No.	Daily Chronometer Rate			Rotation No.	Daily Chronometer Rate		
	Sept. 9–15	Sept. 15–19	Sept. 19–24		Sept. 9–15	Sept. 15–19	Sept. 19–24
	s.	s.	s.		s.	s.	s.
1	−1·151	−1·245	−1·268	27	+ 1·390	+ 1·201	+ 0·732
2	−3·585	−3·862	−3·750	28	+ 0·337	+ 0·144	+ 0·371
3	−4·638	−4·470	−4·846	29	+ 0·650	+ 1·103	+ 0·362
4	−2·031	−2·105	−2·276	36	− 2·169	− 1·961	− 2·196
7	−4·153	−4·221	−4·663	37	− 1·155	− 1·371	− 1·246
8	−2·154	−2·075	−2·446	38	− 3·078	− 3·160	− 3·125
9	−2·549	−2·643	−2·607	39	− 5·272	− 5·853	− 6·196
10	−2·853	−2·787	−3·587	40	− 2·494	− 2·726	− 3·062
11	−5·830	−5·607	−6·001	42	− 0·473	− 0·616	− 0·750
12	+ 0·490	+ 0·269	+ 0·253	43*	+ 1·914	+ 1·613	+ 1·883
13	− 0·110	− 0·278	− 0·342	44	+ 0·130	− 0·536	− 0·816
14	− 0·480	− 0·734	− 0·786	45	+ 1·182	+ 1·276	+ 1·139
15	−2·651	−2·713	−2·862	46	− 5·935	− 7·275	− 7·411
16	−2·915	−3·557	−3·243	47	+ 10·377	+ 9·937	+ 9·751
17	−2·742	−3·626	−4·250	48	+ 10·936	+ 3·276	+ 4·569
18	−2·290	−2·051	−2·452	49	− 3·946	− 5·328	− 5·430
19	+ 0·293	+ 0·704	+ 0·136	51	+ 1·806	+ 0·910	+ 0·687
20	− 5·530	− 6·123	− 5·944	52	+ 0·541	− 0·078	− 0·187
21	− 1·982	− 2·355	− 2·702	A	...	...	− 0·852
22	− 0·378	− 0·566	− 0·655	B	...	...	+ 1·478
23	− 1·028	− 2·005	− 1·040	D	...	...	− 3·951
24	−3·175	−3·637	−3·610	F	...	...	+ 3·698
25	−2·558	−2·439	−2·759	G	...	...	− 4·672
26	+ 2·624	+ 2·370	+ 2·281	H	...	...	+ 5·364

* Chronometer 43 is adjusted to sidereal time.

From September 15–19 H.M.S. 'Shearwater' remained at Mauritius. The rates of the chronometers during this interval are therefore their rates in still water. They differ in the mean from those in the other intervals, which were passed almost entirely at sea, by $-0^s{\cdot}06 \pm 0^s{\cdot}034$—a quantity so small and so uncertain that no allowance has been made for the effect of the ship's motion on the chronometers.

We now give the daily temperatures of the chronometers and the various steps by which they were found :—

Date, 1874	Time by chronometer 36			Local mean time			Time by chrono-metrical thermometer			Correction of chrono-metrical thermometer			Daily rate of chronometrical thermometer	Temperature
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	s.	°
Sept. 9	11	51	0·0	15	37	11·8	9	48	0·5	+ 5	49	11·3		
													+ 51·3	73·4 F.
9	18	22	0·0	22	8	11·2	16	18	46·0	+ 5	49	25·2		
													+ 66·3	75·8
10	18	13	0·0	21	59	9·1	16	8	38·0	+ 5	50	31·1		
													+ 59·5	74·7
11	17	49	20·0	21	35	26·9	15	43	57·3	+ 5	51	29·6		
													+ 65·8	75·7
12	17	5	10·0	20	51	14·8	14	58	41·4	+ 5	52	33·4		
													+ 49·2	73·1
13	17	46	0·0	21	32	2·6	15	38	38·5	+ 5	53	24·1		
													+ 37·4	71·2
14	17	56	0·0	21	42	0·4	15	47	58·5	+ 5	54	1·9		
													+ 33·1	70·5
15	15	54	50·0	19	40	48·5	13	46	16·3	+ 5	54	32·2		
													+ 38·1	71·3
16	17	40	50·0	21	26	46·4	15	31	35·0	+ 5	55	11·4		
													+ 50·4	73·3
17	17	52	20·0	21	38	14·3	15	42	12·0	+ 5	56	2·3		
													+ 55·0	74·0
18	20	37	56·7	0	23	48·9	18	26	45·2	+ 5	57	3·7		
													+ 48·7	73·0
19	17	17	5·3	21	2	55·6	15	5	10·0	+ 5	57	45·6		
													+ 66·4	75·8
20	17	40	0·0	21	25	48·1	15	26	55·0	+ 5	58	53·1		
													+ 53·8	73·8
21	17	51	50·0	21	37	35·9	15	37	48·5	+ 5	59	47·4		
													+ 50·3	73·3
22	16	3	20·0	19	49	3·9	13	48	30·0	+ 6	0	33·9		
													+ 45·4	72·5
23	17	26	30·0	20	12	11·5	15	10	49·5	+ 6	1	22·0		
													+ 37·2	71·2
24	12	29	0·0	16	14	39·8	10	12	48·3	+ 6	1	51·5		

Applying the corrections for these temperatures for each of the chronometers, we get the following table, where R is the maximum *daily gaining* rate :—

Rotation No.	First Run			Second Run		
	R	Temperature correction		R	Temperature correction	
		To Rodriguez	From Rodriguez		To Rodriguez	From Rodriguez
	s.	s.	s.	s.	s.	s.
1	− 1·176	+0·14	+0·01	−1·283	+0·09	+0·00
2	− 3·840	0·69	0·84	−4·008	0·83	0·61
3	− 4·655	0·01	0·08	−4·858	0·02	0·04
4	− 2·313	1·36	0·38	−2·543	1·14	0·36
7	− 4·168	0·06	0·03	−4·668	0·03	0·00
8	− 2·172	0·11	0·00	−2·456	0·06	0·00
9	− 2·622	0·42	0·03	−2·670	0·31	0·05
10	− 2·865	0·05	0·02	−3·590	0·02	0·00
11	− 5·862	0·03	0·16	−6·028	0·05	0·10
12	+ 0·338	0·77	0·16	+0·116	0·61	0·16
13	− 0·180	0·15	0·27	−0·407	0·18	0·18
14	− 0·508	0·17	0·00	−0·808	0·13	0·00
15	− 2·704	0·06	0·25	−2·909	0·11	0·15
16	− 2·975	0·35	0·02	−3·288	0·23	0·02
17	− 2·774	0·19	0·00	−4·272	0·13	0·00
18	− 2·308	0·11	0·00	−2·462	0·06	0·00
19	+ 0·275	0·02	0·08	+0·129	0·01	0·03
20*	− 5·530	...	...	−5·944	...	...
21*	− 1·982	...	...	−2·702	...	...
22	− 0·935	2·59	0·84	−1·190	2·23	0·76
23	− 1·665	2·89	1·03	−1·655	2·54	0·91
24	− 3·250	0·13	0·31	−3·678	0·17	0·21
25	− 3·226	2·02	2·02	−3·436	2·26	1·51
26	+ 2·215	1·91	0·59	+1·894	1·62	0·54
27	+ 1·325	0·38	0·02	+0·679	0·27	0·03
28	+ 0·190	0·76	0·14	+0·236	0·61	0·15
29*	+ 0·650	...	...	+0·362	...	...
36	− 2·399	0·60	0·79	−2·428	0·74	0·56
37	− 1·392	1·01	0·44	−1·483	0·94	0·38
38	− 3·246	0·81	0·24	−3·287	0·68	0·22
39	− 5·295	0·14	0·00	−6·208	0·07	0·00
40	− 2·526	0·19	0·01	−3·087	0·14	0·01
42	− 0·473	0·00	0·00	−0·750	0·00	0·00
43	+ 1·804	0·60	0·08	+1·788	0·45	0·09
44	+ 0·075	0·06	0·26	−0·864	0·11	0·16
45	+ 1·169	0·03	0·05	+1·129	0·02	0·04
46*	− 5·935	...	...	−7·411	...	...
47	+ 9·469	4·05	1·53	+8·869	3·59	1·34
48	+10·514	2·09	0·51	+4·182	1·70	0·48
49	− 3·964	0·11	0·00	−5·440	0·06	0·00
51	+ 1·746	0·35	0·02	+0·637	0·26	0·02
52*	+ 0·541	...	...	−0·187	...	...
A*	...	...	...	−0·852	...	...
B*	...	...	...	+1·478	...	...
D*	...	...	...	−3·951	...	...
F*	...	...	...	+3·698	...	...
G*	...	...	...	−4·672	...	...
H*	...	...	...	+5·364	...	

* We have no temperature corrections for these chronometers; R is the rate unaltered.

Multiplying R by the number of days between the comparisons at Pamplemousses and Rodriguez, and applying this and the corrections for temperature to the chronometer corrections previously given, we get the following corrections to Pamplemousses time at the time of comparison at Rodriguez, where the slight differences between the respective pairs of quantities arise from differences of temperature correction :—

Rotation No.	First Run		Second Run	
	To Rodriguez	From Rodriguez	To Rodriguez	From Rodriguez
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	+3 45 42·91	+3 45 42·91	+3 45 31·35	+3 45 31·34
2	3 39 26·57	3 39 26·58	3 38 51·54	3 38 51·55
3	3 40 19·85	3 40 19·87	3 39 36·17	3 39 36·18
4	3 42 36·37	3 42 36·35	3 42 15·95	3 42 15·94
7	3 39 4·46	3 39 4·46	3 38 23·37	3 38 23·37
8	3 45 24·32	3 45 24·32	3 45 3·25	3 45 3·25
9	3 44 36·58	3 44 36·58	3 44 12·05	3 44 12·04
10	3 41 3·55	3 41 3·55	3 40 34·24	3 40 34·24
11	3 36 30·87	3 36 30·87	3 35 36·27	3 35 36·27
12	3 50 47·34	3 50 47·34	3 50 50·22	3 50 50·22
13	3 51 14·77	3 51 14·78	3 51 12·36	3 51 12·36
14	3 47 48·79	3 47 48·79	3 47 42·29	3 47 42·28
15	3 50 22·48	3 50 22·49	3 49 56·74	3 49 56·75
16	3 47 35·04	3 47 35·04	3 47 4·33	3 47 4·33
17	3 38 36·95	3 38 36·95	3 38 2·66	3 38 2·66
18	3 35 42·59	3 35 42·59	3 35 21·33	3 35 21·33
19	3 49 58·91	3 49 58·92	3 50 2·47	3 50 2·47
20	3 39 54·25	3 39 54·25	3 38 58·93	3 38 58·94
21	3 45 29·78	3 45 29·78	3 45 7·26	3 45 7·27
22	3 43 27·39	3 43 27·34	3 43 21·93	3 43 21·92
23	3 44 31·57	3 44 31·53	3 44 18·41	3 44 18·37
24	3 44 25·12	3 44 25·13	3 43 52·25	3 43 52·25
25	3 46 57·89	3 46 57·91	3 46 33·90	3 46 33·91
26	4 0 42·88	4 0 42·86	4 1 5·16	4 1 5·16
27	4 0 7·08	4 0 7·08	4 0 16·96	4 0 16·96
28	3 48 51·77	3 48 51·76	3 48 54·31	3 48 54·31
29	3 53 30·65	3 53 30·65	3 53 37·17	3 53 37·17
36	3 46 3·33	3 46 3·33	3 45 43·75	3 45 43·74
37	3 48 36·97	3 48 36·96	3 48 25·05	3 48 25·05
38	3 33 43·77	3 33 43·75	3 33 14·33	3 33 14·33
39	3 30 46·18	3 30 46·18	3 29 51·24	3 29 51·24
40	3 44 25·78	3 44 25·77	3 43 59·49	3 43 59·48
42	3 49 13·04	3 49 13·04	3 49 7·08	3 49 7·08
43*	4 5 8·96	4 5 8·96	4 5 25·74	4 5 25·73
44	3 52 51·17	3 52 51·19	3 52 46·69	3 52 46·69
45	3 58 33·93	3 58 33·93	3 58 45·19	3 58 45·19
46	3 39 59·29	3 39 59·30	3 38 53·48	3 38 53·48
47	4 23 23·52	4 23 23·46	4 24 56·24	4 24 56·26
48	4 6 28·50	4 6 28·51	4 7 21·58	4 7 21·57

* Correction to local sidereal time; all the rest to mean time.

Rotation No.	First Run		Second Run	
	To Rodriguez	From Rodriguez	To Rodriguez	From Rodriguez
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
49	3 46 31·37	3 46 31·37	3 45 44·05	3 45 44·04
51	3 52 17·77	3 52 17·77	3 52 27·51	3 52 27·52
52	4 7 39·96	4 7 39·96	4 7 40·26	4 7 40·25
A	...	...	1 37 58·33	1 37 58·33
B	...	...	6 14 12·94	6 14 12·93
D	...	...	2 44 16·65	2 44 16·65
F	...	...	10 47 8·49	10 47 8·49
G	...	...	3 41 53·83	3 41 53·83
H	...	...	3 58 13·87	3 58 13·87

Comparisons of Chronometers at Rodriguez.

1874, September 10.

	h.	m.	s.	Chronometer	h.	m.	s.
Transit clock	10	30	42·0	'Park^{n}. and Frod^{m}.'	18	44	17·4
,,	10	34	13·0	'Cotterell'	19	10	49·5
,,	10	35	32·0	'Hewitt'	19	4	54·0
,,	10	38	33·0	'Carter'	18	7	22·0
,,	10	40	16·0	'Barraud'	18	40	26·0

September 12.

Transit clock	11	56	29·0	'Park^{n}. and Frod^{m}.'	20	5	53·2
,,	12	0	58·0	'Cotterell'	20	33	21·5
,,	12	3	52·0	'Hewitt'	20	29	5·5
,,	12	6	12·0	'Carter'	19	30	49·0
,,	12	9	46·0	'Barraud'	20	5	45·0

September 13.

Transit clock			'Park^{n}. and Frod^{m}.'		
h.	m.	s.	h.	m.	s.
1	43	59·0	19	49	25·8
18	30	34·0	2	33	56·4
18	40	37·0	2	44	56·8
2	10	48·0	10	13	55·0

Transit clock			'Cotterell'		
h.	m.	s.	h.	m.	s.
11	47	28·0	20	15	55·0
18	58	33·0	3	25	48·5
19	4	13·0	3	31	31·5
2	14	7·0	10	40	10·0

Transit clock			'Hewitt'		
h.	m.	s.	h.	m.	s.
11	50	49·0	20	12	9·5
18	35	10·0	2	55	24·5
18	44	52·0	3	5	5·0
2	15	56·0	10	34	55·0

Transit clock			'Carter'		
h.	m.	s.	h.	m.	s.
11	54	32·0	19	15	11·5
18	37	25·0	1	56	57·5
18	46	39·0	2	6	10·0
2	17	49·0	9	36	3·0

Transit clock			'Barraud'		
h.	m.	s.	h.	m.	s.
11	58	1·0	19	50	5·5
18	52	39·0	2	43	35·0
18	55	50·0	2	46	42·0
2	22	7·0	10	11	49·5

Comparisons on board H.M.S. 'Shearwater' with Chronometer 43.

(43)			'Park^{n}. and Frod^{m}.'		
h.	m.	s.	h.	m.	s.
16	46	25·0	5	18	50·0
16	55	47·0	5	28	10·6
18	49	35·0	7	21	40·0
20	29	43·0	9	1	32·0
20	40	44·0	9	12	31·2

(43)			'Cotterell'		
h.	m.	s.	h.	m.	s.
16	37	30·0	5	32	54·0
16	49	45·0	5	45	7·5
18	56	58·0	7	51	59·5
20	30	16·5	9	34	1·0
20	42	7·0	9	36	51·0

(43)			'Hewitt'		
h.	m.	s.	h.	m.	s.
16	44	22·0	5	32	3·0
16	51	23·0	5	38	41·0
18	58	50·0	7	46	47·0
20	30	46·0	9	18	28·0
20	46	10·0	9	33	49·5

(43)			'Carter'		
h.	m.	s.	h.	m.	s.
16	44	48·0	4	32	25·0
16	53	53·0	4	41	28·5
18	48	25·5	6	35	41·0
20	33	46·0	8	20	45·0
20	49	8·0	9	36	4·5

(43)			'Barraud'		
h.	m.	s.	h.	m.	s.
16	40	50·0	5	1	54·0
16	45	43·0	5	4	46·5
18	46	30·0	7	3	14·0
20	37	18·0	8	56	43·5
20	43	20·5	9	2	44·0

1874, SEPTEMBER 13 and 14.

Transit clock			'Park^{n}. and Frod^{m}.'		
h.	m.	s.	h.	m.	s.
11	10	50·0	19	12	28·2
18	50	52·0	2	51	15·2

Transit clock			'Carter'		
h.	m.	s.	h.	m.	s.
11	21	38·0	18	38	24·0
19	20	30·0	2	35	57·0

Transit clock			'Cotterell'		
h.	m.	s.	h.	m.	s.
11	13	26·0	19	37	59·5
18	54	58·0	3	18	15·0

Transit clock			'Barraud'		
h.	m.	s.	h.	m.	s.
11	23	42·0	19	11	55·5
19	38	30·0	3	25	22·5

Transit clock			'Hewitt'		
h.	m.	s.	h.	m.	s.
11	15	13·0	19	32	44·0
19	5	30·0	3	21	44·5

SEPTEMBER 14.

	h.	m.	s.		h.	m.	s.
Transit clock	10	54	37·0	'Park^{n}. and Frod^{m}.'	18	52	25·0
,,	10	56	46·0	'Cotterell'	19	17	28·5
,,	10	59	31·0	'Hewitt'	19	13	11·0
,,	11	4	4·0	'Carter'	18	16	56·5
,,	11	10	54·0	'Barraud'	18	55	14·5

SEPTEMBER 22.

Transit clock			'Park^{n}. and Frod^{m}.'		
h.	m.	s.	h.	m.	s.
12	7	1·0	19	37	31·2
6	11	50·0	13	39	26·0
6	14	16·0	13	41	51·8
10	14	35·0	17	41	31·8

Transit clock			'Carter'		
h.	m.	s.	h.	m.	s.
12	14	33·0	18	59	45·0
6	6	37·0	12	48	53·5
6	28	2·0	13	10	15·0
10	17	8·0	16	58	43·0

Transit clock			'Cotterell'		
h.	m.	s.	h.	m.	s.
12	9	11·0	20	2	1·5
6	9	16·0	13	59	9·0
6	21	37·0	14	11	28·0
10	20	23·0	18	9	34·5

Transit clock			'Barraud'		
h.	m.	s.	h.	m.	s.
12	17	19·0	19	34	9·5
6	7	42·0	13	21	38·5
6	17	4·0	13	30	59·0
10	27	38·0	17	40	52·0

Transit clock			'Hewitt'		
h.	m.	s.	h.	m.	s.
12	11	25·0	19	57	46·0
6	3	30·0	13	46	58·0
6	25	6·0	14	8	30·5
10	24	12·0	18	6	57·5

Comparisons on board H.M.S. 'Shearwater' with Chronometer 43.

(43)			'Park^{n}. and Frod^{m}.'		
h.	m.	s.	h.	m.	s.
3	29	15·0	15	24	51·2
3	33	35·0	15	29	10·4
3	45	17·0	15	40	50·4
3	49	38·0	16	49	46·5
4	54	24·0	16	49	56·4
4	54	24·0	16	49	56·5

(43)			'Carter'		
h.	m.	s.	h.	m.	s.
3	38	4·0	14	48	18·0
3	41	10·0	14	51	23·5
3	47	3·0	14	57	15·5
3	56	1·0	15	6	12·0
4	47	18·0	15	57	20·5
4	50	17·0	16	0	19·0

(43)			(36)		
h.	m.	s.	h.	m.	s.
3	58	46·5	16	11	6·0
3	58	47·0	16	11	7·5
4	42	40·0	16	54	53·5
4	45	43·0	16	57	56·0

(43)			'Cotterell'		
h.	m.	s.	h.	m.	s.
3	35	7·0	15	52	51·5
3	41	7·0	15	58	57·5
3	49	53·0	16	7	42·0
3	53	4·0	16	10	52·5
4	50	21·0	17	8	0·0
4	53	29·0	17	11	7·5

(43)			'Barraud'		
h.	m.	s.	h.	m.	s.
3	31	52·0	15	13	47·5
3	37	58·0	15	19	52·5
3	44	8·0	15	26	1·5
3	55	54·0	15	37	45·5
4	47	32·0	16	29	15·0

(43)			(4)		
h.	m.	s.	h.	m.	s.
4	41	29·0	16	57	10·5
4	44	24·0	17	0	5·0

(43)			'Hewitt'		
h.	m.	s.	h.	m.	s.
3	28	36·0	15	40	3·0
3	34	48·0	15	46	14·0
3	46	51·0	15	58	15·0
3	52	48·0	16	4	11·0
4	48	7·0	16	59	21·0

The preceding comparisons were made by Lieutenant Neate and Mr. Burton; the following by Captain Wharton and Lieutenant Langdon:—

By Captain Wharton.

(43)			(36)		
h.	m.	s.	h.	m.	s.
3	25	23·0	15	37	49·0
3	58	51·5	16	11	12·0

By Lieutenant Langdon.

(43)			(4)		
h.	m.	s.	h.	m.	s.
4	7	59·0	16	23	46·0
4	35	8·5	16	50	51·5

Time Determinations at Rodriguez.

The observations were taken with the Rodriguez transit instrument and transit clock, by Lieutenant Neate and Mr. Burton, who are distinguished respectively by the initials N. and B. in the column headed 'Observer':—

Date, 1874	Observer	Name of star	Position of micrometer	Reading of telescope micrometer	Seconds of transit over the wires					Concluded clock time of transit over wire III.			Level readings	
					I.	II.	III.	IV.	V.				E	W
				r.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Sept. 10	B	μ Herculis	W	20·380	56·5	12·8	29·0	45·1	1·0	17	41	28·96	At $17^h\ 45^m$	
		89 Herculis	,,	,,	45·7	1·7	17·3	33·2	49·1	17	50	17·47	21·7	17·3
		σ Octantis*	,,	,,	...	...	...	...	...	18	15	43·53	63·0	58·7
		,, ,,	E	,,	...	...	...	...	...			44·53	22·3	16·0
		α Lyræ	W	,,	0·8	19·1	37·4	55·5	13·6	18	32	37·37	65·1	58·7
		β^1 Lyræ	,,	,,	48·7	5·9	22·8	39·9	56·7	18	45	22·88		
		ϵ Aquilæ	,,	,,	22·2	37·1	52·0	6·4	21·1	18	53	51·83	At $18^h\ 40^m$	
		ζ Aquilæ	,,	,,	5·5	...	34·9	49·2	4·0	18	59	34·82	21·6	16·8
		ψ Sagittarii	,,	,,	15·9	31·8	47·4	...	18·7	19	7	47·47	64·4	59·5
		ω Aquilæ	,,	,,	22·8	37·3	51·7	6·4	20·7	19	11	51·85		
		δ Aquilæ	,,	,,	38·2	52·4	6·5	20·7	35·0	19	19	6·63		
		α Vulpeculæ	,,	,,	54·1	9·4	25·2	40·9	56·4	19	23	25·27		
		ϵ^1 Sagittarii	,,	,,	58·7	13·8	28·7	43·6	...	19	33	28·68		
Sept. 11	N	β Draconis	W	20·400	41·8	5·3	28·7	52·0	15·1	17	27	28·69	At $16^h\ 40^m$	
		μ Herculis	,,	,,	54·0	9·8	26·0	42·2	58·5	17	41	26·18	22·4	17·3
		γ Draconis	,,	,,	48·2	11·6	34·0	57·3	...	17	53	34·28	63·9	58·5
		μ Sagittarii	,,	,,	38·8	54·5	9·8	24·9	40·2	18	6	9·71	19·9	15·9
		σ Octantis†	,,	,,	...	...	...	...	...	18	15	43·49	64·8	59·7
		,, ,,	E	,,	...	...	...	...	...		16	3·01		
		α Lyræ	,,	,,	11·5	52·6	35·0	16·4	58·5	18	32	34·71	At $18^h\ 30^m$	
		β^1 Lyræ	,,	,,	54·3	37·3	20·2	3·3	46·5	18	45	20·24	21·7	15·0
		ϵ Aquilæ	,,	,,	1·8	47·1	32·3	17·8	3·4	18	59	32·41	66·1	59·1
Sept. 13	N	α Scorpii	W	20·399	...	17·3	32·9	48·7	4·6	16	21	33·00	At $16^h\ 27^m$	
		α^1 Herculis	,,	20·400	...	30·7	45·5	59·7	14·4	17	8	45·28	23·8	15·2
		β Draconis	,,	,,	37·9	1·8	25·0	48·0	11·2	17	27	24·89	65·1	56·9
		μ Herculis	,,	,,	50·3	6·3	22·6	38·8	54·9	17	41	22·66	23·5	15·0
		γ Draconis	,,	,,	44·7	7·8	30·9	53·6	...	17	53	30·76	67·0	57·2

* σ Octantis

W		E	
Micrometer reading	Clock time	Micrometer reading	Clock time
r.	h. m. s.	r.	h. m. s.
22·365	18 5 46·0	21·408	18 20 53·0
22·180	6 42·0	21·564	21 38·0
21·988	7 37·0	21·722	22 28·0
21·788	8 43·0	21·901	23 23·0
21·688	9 14·0	...	...
21·588	9 42·0		
20·670	14 15·0		

† σ Octantis

W		E	
Micrometer reading	Clock time	Micrometer reading	Clock time
r.	h. m. s.	r.	h. m. s.
21·200	18 11 45·0	20·800	18 18 6·0
21·000	12 46·0	21·000	19 3·0
20·800	13 38·0	21·200	20 2·0
20·600	14 45·0	21·400	21 3·0
20·400	15 43·0	21·600	22 2·0

OBSERVATIONS WITH THE RODRIGUEZ TRANSIT INSTRUMENT AND TRANSIT CLOCK—*continued.*
OBSERVERS, LIEUTENANT NEATE AND MR. BURTON.

Date, 1874	Observer	Name of star	Position of micrometer	Reading of telescope micrometer	Seconds of transit over the wires					Concluded clock time of transit over wire III.			Level readings	
					I.	II.	III.	IV.	V.				E	W
				r.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Sept. 14	N	μ Herculis	W	20·400	48·4	4·7	20·9	37·1	53·0	17	41	20·90	At $17^h\ 35^m$	
													22·9	12·5
		μ Sagittarii	,,	,,	33·4	48·6	3·8	18·9	34·1	18	6	3·83	67·0	56·8
		σ Octantis*	,,	,,	...	...	...	...	...	18	16	6·99		
		β^1 Lyræ†	,,	,,	41·2	58·2	15·3	32·4	49·6	18	45	15·42	At $18^h\ 13^m$	
													22·8	10·9
		γ Aquilæ	,,	,,	37·0	51·8	6·3	20·8	35·1	19	40	6·27	68·7	57·1
		α Aquilæ	,,	,,	59·3	13·8	28·1	42·6	56·6	19	44	28·15	At $19^h\ 55^m$	
													23·3	10·0
		β Aquilæ	,,	,,	28·9	43·1	57·3	11·8	26·0	19	48	57·49	70·4	57·0
Sept. 15	B	σ Octantis‡	W	20·380	...	...	...	...	...	18	16	23·00	At $17^h\ 50^m$	
													22·5	11·8
		α Lyræ	,,	,,	49·6	7·9	26·2	44·5	2·4	18	32	26·21	66·7	56·1
		β^1 Lyræ	,,	20·370	37·9	55·0	12·1	28·8	45·8	18	45	12·00	At $18^h\ 0^m$	
													22·4	10·3
		ζ Aquilæ	,,	20·380	54·4	9·3	24·0	38·1	53·0	18	59	23·83	68·4	56·5
		δ Aquilæ	,,	20·378	27·4	41·7	55·9	10·1	24·2	19	18	55·93	At $19^h\ 50^m$	
													22·4	8·5
		γ Aquilæ	,,	,,	34·2	48·9	3·3	17·5	32·0	19	40	3·25	69·5	56·0
													At $19^h\ 55^m$	
													21·7	8·8
													68·8	56·2
Sept. 16	B	μ Herculis	W	20·400	44·3	0·4	16·5	32·6	48·5	17	41	16·54	At $18^h\ 10^m$	
													14·5	17·0
		μ Sagittarii	,,	,,	...	43·6	58·5	14·1	29·6	18	5	58·88	60·7	63·5
		σ Octantis§	,,	20·380	...	...	...	...	...	18	14	3·54		
		ϵ Aquilæ	,,	20·400	9·8	24·6	39·2	54·0	...	18	53	39·31	At $19^h\ 20^m$	
													14·3	16·4
		γ Aquilæ	,,	,,	32·4	46·9	1·3	15·5	...	19	40	1·31	60·7	63·0
		α Aquilæ	,,	,,	54·4	9·0	23·4	37·5	51·8	19	44	23·29	At $20^h\ 41^m$	
		β Aquilæ	,,	,,	24·0	38·4	52·6	7·0	21·1	19	48	52·69	15·1	14·9
													15·2	61·7
		θ Aquilæ	,,	,,	5·0	19·2	33·5	47·8	1·7	20	4	33·51	61·9	15·1
													62·1	62·0
		ϵ Delphini	,,	,,	27·8	42·4	56·9	11·3	25·6	20	26	56·87		

* σ Octantis

Micrometer reading	Clock time
r.	h. m. s.
19·260	18 21 38·0
19·060	22 40·0
18·520	25 31·0
18·310	26 28·0
18·070	27 44·0
17·730	29 26·0
17·300	31 30·0

† Probably touched the micrometer before taking this observation.

‡ σ Octantis

Micrometer reading	Clock time
r.	h. m. s.
21·800	18 9 14·0
21·600	10 14·0
21·400	11 10·5
21·200	12 9·0
20·800	14 15·5
20·500	15 54·0
20·100	17 55·5
19·900	18 49·0
19·700	19 48·0
19·500	20 47·0
19·300	21 47·5
18·800	24 20·0

§ σ Octantis

Micrometer reading	Clock time
r.	h. m. s.
20·600	18 13 2·0
20·523	18 20·0
20·267	19 35·0
19·028	20 48·5
18·800	21 58·0
18·639	22 46·0

OBSERVATIONS WITH THE RODRIGUEZ TRANSIT INSTRUMENT AND TRANSIT CLOCK—*continued.*
OBSERVERS, LIEUTENANT NEATE AND MR. BURTON.

Date, 1874	Observer	Name of star	Position of micrometer	Reading of telescope micrometer	Seconds of transit over the wires I.	II.	III.	IV.	V.	Concluded clock time of transit over wire III.	Level readings E p.	W p.
				r.	s.	s.	s.	s.	s.	h. m. s.		
Sept. 16	B	*a* Cygni	W	20·398	13·1	33·4	53·4	13·4	33·4	20 36 53·43	At 21h 20m	
		B Octantis*	„	20·380	...	...	...	...	...	21 4 38·39	15·4	15·2
											62·3	61·8
Sept. 17	N	σ Octantis †	W	20·380	...	...	...	...	...	18 13 50·08	At 17h 55m	
		β^1 Lyræ	„	20·400	33·9	51·0	7·9	24·9	42·1	18 45 8·04	15·3	19·8
											58·2	62·7
		ω Aquilæ	„	„	...	22·5	36·9	51·3	5·8	19 11 36·92	At 18h 40m	
		δ Aquilæ	„	„	22·8	37·4	51·7	5·9	...	19 18 51·62	14·6	18·5
											59·0	63·1
		γ Aquilæ	„	„	29·7	44·5	58·8	13·0	27·3	19 39 58·73	At 19h 55m	
		a Aquilæ	„	„	51·5	6·3	20·5	35·0	49·3	19 44 20·59	14·6	17·5
											59·7	62·7
		β Aquilæ	„	„	...	35·7	49·9	4·0	18·3	19 48 49·87	At 20h 33m	
		A Octantis S.P.‡	„	20·380	...	...	...	...	...	20 10 13·24	15·0	17·1
											60·1	62·0
Sept. 18	B	μ Sagittarii	W	20·401	22·0	37·3	52·5	7·7	23·0	18 5 52·57	At 17h 49m	
		σ Octantis §	„	20·380	...	...	...	...	...	18 13 47·57	15·7	19·6
											56·0	61·1
		„	E	„	...	...	...	...	...	48·39		
		a Lyræ	„	20·400	55·8	37·4	19·0	1·1	43·0	18 32 19·17	At 18h 25m	
		β^1 Lyræ	W	„	30·3	47·3	4·4	21·3	38·3	18 45 4·40	15·5	18·9
		ζ Aquilæ	„	„	46·8	1·1	16·1	30·4	45·0	18 59 15·95	58·5	62·1
		ω Aquilæ	„	20·398	3·9	18·5	33·0	47·4	1·8	19 11 32·99		
		γ Aquilæ	„	20·400	26·0	40·4	55·0	9·3	23·8	19 39 54·97	At 18h 40m	
		a Aquilæ	„	20·398	48·0	2·7	17·0	31·2	45·4	19 44 16·93	14·5	19·2
		β Aquilæ	„	20·400	17·4	32·0	46·3	0·6	14·7	19 48 46·27	57·9	62·9
		a^2 Capricorni	„	„	...	28·3	42·5	57·2	11·9	20 10 42·72		
		a Pavonis	„	„	27·5	54·0	20·1	46·4	12·4	20 15 20·20		

* B Octantis

Mic. reading	Clock time
r.	h. m. s.
21·600	20 56 51·5
21·400	58 13·0
21·300	58 52·0
21·200	59 29·0
21·100	21 0 5·0
21·000	0 42·0
20·900	1 20·0
20·800	1 58·5
20·700	2 38·5
20·600	3 16·5
20·500	3 54·0
20·400	4 31·0
20·300	5 12·0
20·200	5 52·0

B Octantis (*cont.*)

Micrometer reading	Clock time
r.	h. m. s.
19·700	21 8 54·5
19·500	10 14·0
19·300	11 25·5
19·100	12 39·0
19·000	13 26·0
18·800	14 29·5

‡ A Octantis S.P.

Micrometer reading	Clock time
r.	h. m. s.
21·976	20 13 59·0
22·437	15 6·0
22·776	15 57·0
23·128	16 45·0
23·472	17 37·0
23·786	18 18·0

† σ Octantis

Micrometer reading	Clock time
r.	h. m. s.
21·000	18 10 43·0
20·800	11 44·0
20·600	12 44·0
20·400	13 43·0
18·772	21 57·0
18·574	22 55·0
18·367	23 56·0
18·177	24 45·0
17·946	26 2·0

§ σ Octantis

W		E	
Micrometer reading	Clock time	Micrometer reading	Clock time
r.	h. m. s.	r.	h. m. s.
21·353	18 8 55·0	20·356	18 13 39·5
20·858	11 24·5	21·109	17 27·0
		21·954	21 43·0

OBSERVATIONS WITH THE RODRIGUEZ TRANSIT INSTRUMENT AND TRANSIT CLOCK—*continued.*
OBSERVERS, LIEUTENANT NEATE AND MR. BURTON.

Date, 1874	Observer	Name of star	Position of micrometer	Reading of telescope micrometer	Seconds of transit over the wires I.	II.	III.	IV.	V.	Concluded clock time of transit over wire III. h.	m.	s.	Level readings E p.	W p.
				r.	s.	s.	s.	s.	s.					
Sept. 19	B	α Lyræ	W	20·376	...	...	15·1	33·3	51·4	18	32	15·12	At 18h 30m	
		β^1 Lyræ	„	20·378	26·4	43·6	0·7	17·5	34·4	18	45	0·60	14·7	19·8
		π Sagittarii	„	„	21·2	36·3	51·5	6·7	22·0	19	1	51·61	56·4	62·9
		h^2 Sagittarii	„	20·390	6·0	22·0	37·6	53·4	8·8	19	28	37·63	At 19h 34m	
		γ Aquilæ	„	20·377	22·3	36·5	51·4	...	20·0	19	39	51·24	14·6	18·5
		α Aquilæ	„	„	...	...	13·3	27·4	41·7	19	44	13·14	59·2	63·2
		β Aquilæ	„	20·367	13·9	28·4	42·6	56·9	10·8	19	48	42·59	At 19h 55m	
		A Octantis S.P.*	„	20·380	...	...	...	...	...	20	9	48·60	14·4	18·2
		B Octantis †	„	„	...	...	...	...	...	21	4	10·96	59·2	63·2
													At 21h 30m	
													15·4	17·8
													59·4	62·2
Sept. 20	N	μ Sagittarii	W	20·380	14·3	29·8	45·2	0·2	15·7	18	5	45·11	At 18h 0m	
		σ Octantis‡	„	„	...	...	...	...	...	18	13	51·78	15·8	19·9
		β^1 Lyræ	„	20·378	22·6	40·0	56·9	14·0	30·7	18	44	56·92	57·0	61·1
		α Aquilæ	„	„	40·6	55·3	9·5	23·9	38·2	19	44	9·57	At 18h 40m	
	B	θ Aquarii	W	20·378	10·0	24·6	38·4	53·1	...	22	9	38·77	14·5	18·9
		ζ Pegasi	„	„	9·6	24·0	38·4	52·8	...	22	34	38·48	58·2	62·7
		α Piscis Aust.	„	„	35·7	52·5	8·6	25·1	41·5	22	50	8·76	At 20h 21m	
		α Pegasi	„	„	27·3	42·0	56·5	11·4	26·0	22	57	56·71	14·6	16·7
		γ Piscium	„	„	37·2	51·4	5·5	20·0	33·9	23	10	5·67	59·3	61·0
		κ Piscium	„	„	27·4	41·9	56·0	10·3	24·4	23	19	56·07	At 22h 43m	
		ι Piscium	„	„	27·4	41·5	55·6	9·9	24·1	23	32	55·77	14·8	16·6
		δ Sculptoris	„	„	16·4	32·9	49·0	5·4	21·3	23	41	49·08	59·7	61·4
		ω Piscium	„	„	49·3	3·5	18·0	32·4	46·5	23	52	18·01	At 23h 26m	
		α Andromedæ	„	20·377	47·1	3·4	19·8	35·7	51·8	0	1	19·64	14·7	16·3
		o Octantis§	„	20·380	...	...	...	...	...	0	13	54·08	59·7	61·3

* A Octantis S.P.

Micrometer reading	Clock time h.	m.	s.
r.			
18·700	20	5	48·0
19·000		6	31·0
19·200		7	0·0
20·300		9	39·0

† B Octantis

Micrometer reading	Clock time h.	m.	s.
r.			
21·564	20	56	41·0
21·344		58	3·0
18·357	21	16	54·0
17·972		19	20·0
17·652		21	26·0
17·480		22	38·0
17·224		23	57·0

§ *o* Octantis

Micrometer reading	Clock time h.	m.	s.	Micrometer reading	Clock time h.	m.	s.
r.				r.			
22·800	0	4	41·0	19·916	0	15	40·0
21·334		10	17·0	19·685		16	33·0
20·369		13	58·0	17·714		21	1·0

Sept. 19

Collimation by collimator W	E
r.	r.
22·318	18·488
·293	·497
·293	·474
·288	·488
·282	·483
·295	·483

‡ σ Octantis

Micrometer reading	Clock time h.	m.	s.
r.			
20·213	18	14	40·0
19·456		18	31·0
18·717		22	14·0
18·557		22	59·0
18·436		23	36·0
18·305		24	13·0
18·208		24	45·0
18·094		25	17·0
17·683		27	20·0
17·351		29	4·0
17·196		29	48·0

OBSERVATIONS WITH THE RODRIGUEZ TRANSIT INSTRUMENT AND TRANSIT CLOCK—*continued.*
OBSERVERS, LIEUTENANT NEATE AND MR. BURTON.

Date, 1874	Observer	Name of star	Position of micrometer	Reading of telescope micrometer	Seconds of transit over the wires I.	II.	III.	IV.	V.	Concluded clock time of transit over wire III.	Level readings E p.	W p.
				r.	s.	s.	s.	s.	s.	h. m. s.		
Sept. 21	N	A Octantis S.P.*	W	20·380	...	...	...	...	...	20 9 51·57	At 18h 15m	
											14·9	18·6
											58·2	62·0
		α Cygni	„	„	55·7	15·9	36·0	56·0	16·0	20 36 36·01		
		B Octantis†	„	„	...	...	...	...	...	21 4 20·46		
		ε Pegasi	„	20·378	59·0	13·8	28·3	42·7	56·9	21 37 28·21	At 20h 30m	
											15·0	16·8
											60·5	62·0
	B	C Octantis‡	„	20·380	...	...	...	...	...	22 6 44·24		
	N	η Aquarii	„	„	53·0	7·3	...	35·3	49·5	22 28 21·36	At 22h 18m	
											10·8	11·1
		ζ Pegasi	„	„	9·9	24·4	39·0	53·4	7·5	22 34 38·91	56·5	56·8
	B	γ Piscium	„	20·380	37·8	52·0	6·4	20·5	34·4	23 10 6·29		
		κ Piscium	„	20·381	28·1	42·4	56·4	10·9	25·0	23 19 56·63	At 22h 40m	
											10·1	11·1
											55·8	56·7
		ι Piscium	„	„	28·0	42·3	56·3	10·5	24·9	23 32 56·47		
		δ Sculptoris	„	„	17·6	34·0	50·1	6·2	22·3	23 41 50·12	At 23h 30m	
											10·4	10·2
		α Andromedæ	„	„	48·5	4·6	20·8	37·0	52·9	0 1 20·84	56·1	56·1
		γ Pegasi	„	„	...	58·4	13·1	27·6	42·4	0 6 13·08		
Sept. 22	B	α Lyræ	W	20·380	28·6	47·0	5·4	23·5	41·5	18 32 5·29	At 19h 33m	
											9·1	10·4
		ζ Aquilæ	„	„	...	...	2·1	16·6	31·1	18 59 2·02	54·7	56·1
		ω Aquilæ	„	„	50·1	4·6	19·3	33·6	48·1	19 11 19·21		
		δ Aquilæ	„	„	5·4	19·6	34·0	48·1§	2·2	19 18 33·93	At 20h 23m	
											9·7	9·4
		h^2 Sagittarii	„	„	56·4	12·1	27·9	43·6	59·0	19 28 27·87	55·8	55·6
		γ Aquilæ	„	„	12·3	26·7	41·2	55·6	10·0	19 39 41·23	At 20h 41m	
		α Aquilæ	„	„	34·5	48·8	3·4	17·5	31·8	19 44 3·27	15·1	14·9
											61·9	61·1
		Aquilæ	„	„	3·9	18·2	32·6	46·9	1·2	19 48 32·63		
		A Octantis S.P.‖	„	„	...	...	...	...	...	20 9 41·41	At 21h 23m	
											9·4	9·9
		α Cygni	„	„	53·0	13·3	33·2	53·1	13·0	20 36 33·21	55·6	56·2
		B Octantis¶	„	„	...	...	...	...	...	21 4 22·07		
		δ Capricorni	„	„	0·9	15·9	30·7	45·5	0·2	21 39 30·71		

* A Octantis S.P.

Mic. reading	Clock time	Mic. reading	Clock time
r.	h. m. s.	r.	h. m. s.
24·921	20 20 41·0	25·786	20 22 45·0
25·284	21 33·0	26·074	23 24·0
25·495	22 0·0	26·272	23 50·0

† B Octantis

Mic. reading	Clock time
r.	h. m. s.
22·100	20 53 35·0
21·900	54 44·0
21·700	55 55·0
21·600	56 41·0
21·500	57 18·0
21·400	57 53·0
21·200	59 6·0
20·900	21 0 59·0
20·800	1 43·0
20·700	2 24·0
20·500	3 44·0

Sept. 21

Collimation by collimator E	W
r.	r.
22·064	18·700
·053	·695
·058	·692
·059	·693
·061	·704
·052	·691
·062	·691
·051	·708
·067	·700
·050	·693

‡ C Octantis

Mic. reading	Clock time
r.	h. m. s.
23·100	22 3 53·0
22·100	4 55·5
21·100	5 57·0
20·100	7 2·5
19·100	8 5·0
18·100	9 9·0
17·100	10 12·0
16·100	11 15·0
15·100	12 18·0

‖ A Octantis S.P.

Mic. reading	Clock time
r.	h. m. s.
22·200	20 14 1·0
22·700	15 12·0
22·950	15 44·0
23·200	16 25·5
23·450	17 0·0
23·700	17 32·0
23·950	18 9·5
24·200	18 51·0
24·450	19 24·5

§ 46·1 seconds in original.

¶ B Octantis

Mic. reading	Clock time	Mic. reading	Clock time
r.	h. m. s.	r.	h. m. s.
21·200	20 59 15·0	20·200	21 5 24·0
21·000	21 0 32·0	20·000	6 47·0
20·800	1 48·0	19·800	7 59·0
20·600	3 1·0	19·600	9 15·0
20·400	4 11·0	19·400	10 31·0

OBSERVATIONS WITH THE RODRIGUEZ TRANSIT INSTRUMENT AND TRANSIT CLOCK—*continued.*
OBSERVERS, LIEUTENANT NEATE AND MR. BURTON.

Date, 1874	Observer	Name of star	Position of micrometer	Reading of telescope micrometer	Seconds of transit over the wires I.	II.	III.	IV.	V.	Concluded clock time of transit over wire III.	Level readings E p.	W p.
				r.	s.	s.	s.	s.	s.	h. m. s.		
Sept. 22	N	C Octantis *	W	20·380	...	...	...	...	...	22 6 51·30	At 19h 55m	
		η Aquarii	,,	,,	49·5	4·0	18·2	32·3	46·5	22 28 18·17	9·2	9·1
		ζ Pegasi	,,	,,	7·0	21·7	36·0	50·4	4·8	22 34 36·05	55·7	55·3
		τ Octantis †	,,	,,	...	...	...	...	...	23 8 21·75	At 23h 25m	
		,,	E	,,	...	...	...	...	...	23·81	56·7	9·0
		κ Piscium	,,	,,	22·4	8·0	53·8	39·7	25·5	23 19 53·81	10·0	55·8
		ι Piscium	,,	,,	22·5	8·0	53·5	39·3	25·2	23 32 53·63	At 0h 20m	
		12 Ceti	W	,,	33·5	47·9	2·0	16·1	30·1	0 23 1·98	8·4	8·5
											55·8	55·9
Sept. 23	N	ρ Capricorni	W	20·380	32·8	47·9	2·8	18·0	32·8	20 21 2·93	At 20h 5m	
		α Cygni	,,	,,	49·8	10·0	29·9	50·0	9·9	20 36 30·01	9·2	10·8
		η Aquarii	,,	,,	46·5	1·0	15·2	29·4	43·4	22 28 15·17	55·2	56·7
		ζ Pegasi	,,	,,	3·9	18·6	32·9	47·5	1·9	22 34 33·03	At 21h 55m	
		κ Piscium	,,	,,	21·7	36·1	50·0	4·2	18·1	23 19 50·09	9·1	9·2
	B	ο Octantis‡	W	20·380	...	...	...	...	...	0 14 1·73	55·7	55·8
		26 Ceti	,,	,,	13·4	27·5	42·1	56·2	10·3	0 56 41·97	At 23h 15m	
		θ Ceti	,,	,,	36·4	51·1	5·5	19·7	34·3	1 17 5·47	10·1	8·2
		η Piscium	,,	,,	37·0	51·9	6·4	21·2	35·6	1 24 6·49	57·2	55·2
		α Eridani	,,	,,	30·4	57·4	24·3	50·7	17·1	1 32 24·10	At 0h 35m	
		β Arietis	,,	,,	32·5	47·7	2·8	17·9	33·1	1 47 2·87	9·5	7·9
		α Arietis	,,	,,	55·4	10·5	26·4	41·7	57·0	1 59 26·27	56·7	55·3
		67 Ceti	,,	,,	35·0	49·4	3·6	17·5	31·8	2 10 3·63	At 1h 30m	
		ξ^2 Ceti	,,	,,	20·5	35·0	49·3	3·5	17·9	2 20 49·31	9·9	7·6
											57·4	54·9
											At 2h 30m	
											8·7	7·3
											57·2	55·7

* C Octantis

Micrometer reading	Clock time
r.	h. m. s.
15·850	22 11 33·0
15·000	12 29·0
14·500	12 59·0
13·700	13 47·0
13·200	14 20·0
12·500	15 1·0
12·000	15 35·0
11·500	16 8·0
11·000	16 36·0
10·500	17 9·5

Sept. 23

Collimation by collimator	
W	E
r.	r.
22·824	17·945
·821	·948
·821	·945
·823	·948
·822	·948
·820	·946
·817	·948

‡ ο Octantis

Micrometer reading	Clock time	Micrometer reading	Clock time
r.	h. m. s.	r.	h. m. s.
23·200	0 3 23·0	20·300	0 14 19·0
22·600	5 35·0	20·000	15 25·0
22·300	6 47·0	19·698	16 36·0
21·400	10 7·0	19·000	19 13·0
21·100	11 14·0	17·898	23 31·0
20·600	13 11·0	17·500	25 3·0

† τ Octantis

W				E			
Micrometer reading	Clock time	Micrometer reading	Clock time	Micrometer reading	Clock time	Micrometer reading	Clock time
r.	h. m. s.	r.	h. m. s.	r.	h. m. s.	r.	h. m. s.
22·300	23 4 35·0	21·100	23 6 56·0	21·400	23 10 24·0	22·300	23 12 10·0
22·000	5 12·0	20·800	7 34·0	21·700	10 59·0	22·600	12 45·0
21·700	5 47·0	20·500	8 9·0	22·000	11 32·0		
21·400	6 21·0						

The Instrumental Corrections.

As the levellings taken at irregular intervals showed a marked progressive change, probably due to the heating effect of the lamp, Mr. Gill graphically constructed from them a table (given below) showing the inclination at each hour of sidereal time; from it the level corrections were interpolated. The value of one part of the level is $0^s{\cdot}1026$; there is no known correction for inequality of pivots.[1]

Date	h. 16	h. 17	h. 18	h. 19	h. 20	h. 21	h. 22	h. 23	h. 0	h. 1	h. 2	h. 3
	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
1874, Sept. 10	...	+0·21	+0·23	+0·25								
„ 11	+0·27	+0·30	+0·33	+0·37	+0·41	+0·45	+0·48					
„ 13	+0·41	+0·45	+0·49									
„ 14	...	+0·50	+0·57	+0·63	+0·69							
„ 15	...	+0·50	+0·57	+0·63	+0·69							
„ 16	...	...	−0·17	−0·10	−0·05	+0·01	+0·03	+0·03				
„ 17	...	−0·27	−0·22	−0·19	−0·14	−0·11						
„ 18	...	−0·27	−0·23	−0·20	−0·15	−0·11						
„ 19	...	−0·31	−0·25	−0·20	−0·15	−0·12						
„ 20	...	...	−0·25	−0·20	−0·13	−0·08	−0·03	+0·02	+0·07			
„ 21	...	...	−0·22	−0·19	−0·13	−0·08	−0·03	+0·02	+0·07			
„ 22	...	...	−0·20	−0·13	0·00	+0·03	+0·06	+0·06	+0·01	−0·04		
„ 23	...	...	...	...	−0·10	−0·03	+0·02	+0·07	+0·09	+0·11	+0·11	+0·09

The collimation correction was determined on some days by observing pole stars in both positions of the instrument, and on others by a collimator; as the micrometer moved the whole system of wires, the corrections for collimation given below correspond only to the reading of the micrometer head given with them; the correction for any other reading can be found from the value of the micrometer screw, $1^r = 3^s{\cdot}7463$. The readings increase when the wires are moved towards the head of the screw, which is divided into 100 parts. There was no determination of collimation from September 13 to 17; the correction on each of these days has been assumed. The azimuth has been determined by combining the various pole stars with one or more time stars; the correction for September 13 has been assumed, no pole star having been observed on that day.

Date	Object	Reading of mic. head	Corresponding collimation, mic. W.	Adopted azimuth
		r.	s.	s.
1874, Sept. 10	σ Octantis	20·380	+0·007	+0·562
„ 11	σ Octantis	20·380	+0·047	+0·779
„ 13	...	20·400	+0·095	+1·067
„ 14	...	20·400	+0·095	+1·211
„ 15	...	20·400	+0·095	+1·472
„ 16	...	20·400	+0·095	−0·469
„ 17	...	20·400	+0·095	−0·696
„ 18	σ Octantis	20·380	+0·005	−0·725
„ 19	Collimator	20·390	0·000	−0·423
„ 20	...	20·380	+0·020	−0·520
„ 21	Collimator	20·378	0·000	−0·335
„ 22	...	20·380	+0·020	−0·191
„ 23	Collimator	20·380	+0·015	−0·095

[1] The divisions of the level are numbered from end to end, increasing from the cross level; the letters E and W give the position of the cross level. Some observations subsequently found amongst Mr. Burton's notes show that the pivot next the micrometer is $0^s{\cdot}006$ thinner than the other. The omission of this correction does not affect the final longitude by $0^s{\cdot}01$.

For the sake of completeness we now give the corrections and the result for each star, repeating the clock time of transit over wire III. :—

Date, 1874	Epoch by clock	Name of star	Observer	Concluded clock time of transit over wire III.	Sum of instrumental corrections	R.A. of star, including daily aberration	Clock correction
	h. m.			h. m. s.	s.	h. m. s.	s.
Sept. 10	18 50·6	μ Herculis	B	17 41 28·96	+0·65	17 41 33·19	+3·58
		89 Herculis		17 50 17·47	+0·65	17 50 21·81	3·69
		α Lyræ		18 32 37·37	+0·81	18 32 41·97	3·79
		β^1 Lyræ		18 45 22·88	+0·74	18 45 27·43	3·81
		ϵ Aquilæ		18 53 51·83	+0·57	18 53 56·21	3·81
		ζ Aquilæ		18 59 34·82	+0·56	18 59 39·15	3·77
		ψ Sagittarii		19 7 47·47	+0·23	19 7 51·52	3·82
		ω Aquilæ		19 11 51·85	+0·54	19 11 56·25	3·86
		δ Aquilæ		19 19 6·63	+0·50	19 19 10·98	3·87
		α Vulpeculæ		19 23 25·27	+0·65	19 23 29·79	3·87
		e^1 Sagittarii		19 33 28·68	+0·33	19 33 32·92	3·91
Sept. 11	18 12·3	β Draconis	N	17 27 28·69	+1·53	17 27 36·15	+5·93
		μ Herculis		17 41 26·18	+0·99	17 41 33·16	5·99
		γ Draconis		17 53 34·28	+1·50	17 53 42·05	6·27
		μ Sagittarii		18 6 9·71	+0·44	18 6 15·92	5·77
		α Lyræ		18 32 34·71	+0·96	18 32 41·95	6·28
		β^1 Lyræ		18 45 20·24	+0·90	18 45 27·41	6·27
		ζ Aquilæ		18 59 32·41	+0·66	18 59 39·13	6·06
Sept. 13	17 18·6	α Scorpii	N	16 21 33·00	+0·44	16 21 42·60	+9·16
		α Herculis		17 8 45·28	+1·11	17 8 55·63	9·24
		β Draconis		17 27 24·89	+2·05	17 27 36·09	9·15
		μ Herculis		17 41 22·66	+1·36	17 41 33·12	9·10
		γ Draconis		17 53 30·76	+2·03	17 53 41·99	9·20
Sept. 14	19 0·0	μ Herculis	N	17 41 20·90	+1·53	17 41 33·10	+10·67
		μ Sagittarii		18 6 3·83	+0·67	18 6 15·87	11·37
		γ Aquilæ		19 40 6·27	+1·21	19 40 7·58	10·79
		α Aquilæ		19 44 28·15	+1·25	19 44 29·40	11·01
		β Aquilæ		19 48 57·49	+1·24	19 48 58·73	11·03
Sept. 15	19 3·0	α Lyræ	B	18 32 26·21	+2·03	18 32 41·85	+13·61
		β^1 Lyræ		18 45 12·00	+1·84	18 45 27·32	13·48
		ζ Aquilæ		18 59 23·83	+1·41	18 59 39·07	13·83
		δ Aquilæ		19 18 55·93	+1·19	19 19 10·91	13·79
		γ Aquilæ		19 40 3·25	+1·35	19 40 18·36	13·76
Sept. 16	19 27·0	μ Herculis	B	17 41 16·54	−0·42	17 41 33·06	+16·94
		μ Sagittarii		18 5 58·88	−0·06	18 6 15·84	17·02
		ϵ Aquilæ		18 53 39·31	−0·26	18 53 56·12	17·07
		γ Aquilæ		19 40 1·31	−0·20	19 40 18·35	17·24
		α Aquilæ		19 44 23·29	−0·18	19 44 40·39	17·28
		β Aquilæ		19 48 52·69	−0·15	19 49 9·74	17·20
		θ Aquilæ		20 4 33·51	−0·09	20 4 50·66	17·24
		ϵ Delphini		20 26 56·87	−0·17	20 27 13·96	17·26
		α Cygni		20 36 53·43	−0·49	20 37 10·26	17·32

Date, 1874	Epoch by clock	Name of star	Observer	Concluded clock time of transit over wire III.	Sum of instrumental corrections	R.A. of star, including daily aberration	Clock correction
	h. m.			h. m. s.	s.	h. m. s.	s.
Sept. 17	19 24·8	β^1 Lyræ	N	18 45 8·04	−0·69	18 45 27·28	+19·93
		ω Aquilæ		19 11 36·92	−0·43	19 11 56·15	19·66
		δ Aquilæ		19 18 51·62	−0·33	19 19 10·88	19·59
		γ Aquilæ		19 39 58·73	−0·39	19 40 18·33	19·99
		α Aquilæ		19 44 20·59	−0·36	19 44 40·37	20·14
		β Aquilæ		19 48 49·87	−0·33	19 49 9·72	20·18
Sept. 18	19 19·4	μ Sagittarii	B	18 5 52·57	−0·11	18 6 15·81	+23·35
		α Lyræ		18 32 19·17	−1·04	18 32 41·78	23·65
		β^1 Lyræ		18 45 4·40	−0·73	18 45 27·26	23·59
		ζ Aquilæ		18 59 15·95	−0·48	18 59 39·02	23·55
		ω Aquilæ		19 11 32·99	−0·46	19 11 56·13	23·60
		γ Aquilæ		19 39 54·97	−0·42	19 40 18·32	23·77
		α Aquilæ		19 44 16·93	−0·39	19 44 40·36	23·82
		β Aquilæ		19 48 46·27	−0·36	19 49 9·71	23·80
		α^2 Capricorni		20 10 42·72	−0·13	20 11 6·44	23·85
		α Pavonis		20 15 20·20	+0·78	20 15 44·60	23·62
Sept. 19	19 17·3	α Lyræ	B	18 32 15·12	−0·60	18 32 41·76	+27·24
		β^1 Lyræ		18 45 0·60	−0·54	18 45 27·24	27·18
		π Sagittarii		19 1 51·61	−0·20	19 2 18·67	27·26
		h^2 Sagittarii		19 28 37·63	−0·10	19 29 5·04	27·51
		γ Aquilæ		19 39 51·24	−0·36	19 40 18·30	27·42
		α Aquilæ		19 44 13·14	−0·34	19 44 40·34	27·54
		β Aquilæ		19 48 42·59	−0·35	19 49 9·69	27·45
Sept. 20	18 51·7	μ Sagittarii	N	18 5 45·11	−0·22	18 6 15·78	+30·89
		β^1 Lyræ		18 44 56·92	−0·63	18 45 27·22	30·93
		α Aquilæ		19 44 9·57	−0·35	19 44 40·33	31·11
	23 21·1	θ Aquarii	B	22 9 38·77	+3·71	22 10 14·00	+31·52
		ζ Pegasi		22 34 38·48	+3·62	22 35 13·44	31·34
		α Piscis Aust.		22 50 8·76	+4·45	22 50 44·61	31·40
		α Pegasi		22 57 56·71	+3·69	22 58 31·90	31·50
		γ Piscium		23 10 5·67	+3·64	23 10 40·92	31·61
		κ Piscium		23 19 56·07	+3·66	23 20 31·34	31·61
		ι Piscium		23 32 55·77	+3·65	23 33 31·13	31·71
		δ Sculptoris		23 41 49·08	+4·42	23 42 25·07	31·57
		ω Piscium		23 52 18·01	+3·66	23 52 53·43	31·76
		α Andromedæ		0 1 19·64	+4·00	0 1 55·48	31·84
Sept. 21	21 49·2	α Cygni	N	20 36 36·01	−0·47	20 37 10·15	+34·61
		ϵ Pegasi		21 37 28·21	−0·19	21 38 2·50	34·48
		η Aquarii		22 28 21·36	−0·10	22 28 55·76	34·50
		ζ Pegasi		22 34 38·91	−0·15	22 35 13·44	34·68
	23 38·7	γ Piscium	B	23 10 6·29	−0·13	23 10 40·93	+34·77
		κ Piscium		23 19 56·63	−0·10	23 20 31·35	34·82
		ι Piscium		23 32 56·47	−0·12	23 33 31·13	34·78
		δ Sculptoris		23 41 50·12	+0·17	23 42 25·08	34·79
		α Andromedæ		0 1 20·84	−0·28	0 1 55·49	34·93
		γ Pegasi		0 6 13·08	−0·17	0 6 47·81	34·90

Date, 1874	Epoch by clock	Name of star	Observer	Concluded clock time of transit over wire III.	Sum of instrumental corrections	R.A. of star, including daily aberration	Clock correction
	h. m.			h. m. s.	s.	h. m. s.	s.
Sept. 22	19 41·9	*α* Lyræ	B	18 2 5·29	−0·29	18 32 41·68	+36·68
		ζ Aquilæ		18 9 2·02	−0·21	18 59 38·95	37·14
		ω Aquilæ		19 11 19·21	−0·18	19 11 56·07	37·04
		δ Aquilæ		19 18 33·93	−0·15	19 19 10·81	37·03
		h^2 Sagittarii		19 28 27·87	−0·03	19 29 5·00	37·16
		γ Aquilæ		19 39 41·23	−0·12	19 40 18·26	37·15
		α Aquilæ		19 44 3·27	−0·10	19 44 40·30	37·13
		β Aquilæ		19 48 32·63	−0·08	19 49 9·65	37·10
		α Cygni		20 36 33·21	−0·20	20 37 10·13	37·12
		δ Capricorni		21 39 30·71	+0·06	21 40 8·14	37·37
	23 15·8	*η* Aquarii	N	22 28 18·17	0·00	22 28 55·76	+37·59
		ζ Pegasi		22 34 36·05	−0·04	22 35 13·44	37·43
		κ Piscium		23 19 53·81	−0·05	23 20 31·35	37·59
		ι Piscium		23 32 53·63	−0·08	23 33 31·14	37·59
		12 Ceti		0 23 1·98	−0·03	0 23 39·41	37·48
Sept. 23	21 52·0	*ρ* Capricorni	N	20 21 2·93	−0·06	20 21 43·08	+40·21
		α Cygni		20 36 30·01	−0·13	20 37 10·11	40·23
		η Aquarii		22 28 15·17	+0·03	22 28 55·76	40·56
		ζ Pegasi		22 34 33·03	+0·01	22 35 13·44	40·40
		κ Piscium		23 19 50·09	+0·06	23 20 31·35	41·20
	1 40·9	26 Ceti	B	0 56 41·97	+0·09	0 57 22·90	+40·84
		θ Ceti		1 17 5·47	+0·11	1 17 46·49	40·91
		η Piscium		1 24 6·49	+0·05	1 24 47·47	40·93
		α Eridani		1 32 24·10	+0·31	1 33 5·38	40·97
		β Arietis		1 47 2·87	+0·04	1 47 43·79	40·88
		α Arietis		1 59 26·27	+0·03	2 0 7·31	41·01
		67 Ceti		2 10 3·53	+0·10	2 10 44·76	41·13
		ξ^2 Ceti		2 20 49·31	+0·07	2 21 30·46	41·08

To combine the results from the separate stars the daily mean was taken for each observer, and then $-0^s{\cdot}30$ (see Chap. V.) was applied to Mr. Burton's corrections to reduce them to the standard of Lieutenant Neate. On the four last days a final mean was struck between the two observers.

Date, 1874	Observer	Clock correction	Epoch by clock	Clock correction reduced to N
		s.	h. m.	s.
Sept. 10 . . .	B	+ 3·80	18 50·6	+ 3·50
„ 11 . . .	N	6·08	18 12·3	6·08
„ 13 . . .	N	9·17	17 18·6	9·17
„ 14 . . .	N	10·97	19 0·0	10·97
„ 15 . . .	B	13·69	19 3·0	13·39
„ 16 . . .	B	17·18	19 27·0	16·88
„ 17 . . .	N	19·915	19 24·8	19·915
„ 18 . . .	B	23·66	19 19·4	23·36
„ 19 . . .	B	27·37	19 17·3	27·07
„ 20 . . .	N	30·98	21 6·4	31·135
	B	31·59		
„ 21 . . .	N	34·57	22 44·0	34·55
	B	34·83		
„ 22 . . .	B	37·09	21 28·8	37·165
	N	37·54		
„ 23 . . .	N	40·52	23 46·5	+40·595
	B	40·97		

These time determinations, and the comparisons with the transit clock on pages 94 and 95, lead to the following corrections of the portable timekeepers at Rodriguez :—

Date, 1874	Chronometer																	
	'Parkinson and Frodsham'			'Cotterell'			'Hewitt'			'Carter'			'Barraud'					
	Epoch by 'P. and F.'		Chronometer correction	Epoch by 'Cotterell'		Chronometer correction	Epoch by 'Hewitt'		Chronometer correction	Epoch by 'Carter'		Chronometer correction	Epoch by 'Barraud'		Chronometer correction			
	h.	m.	h. m. s.	h.	m.	h. m. s.	h.	m.	h. m. s.	h.	m.	h. m. s.	h.	m.	h. m. s.			
Sept. 10	18	44·3	+4 25 58·92	19	10·8	+4 2 57·26	19	4·9	+4 10 11·54	18	7·4	+5 10 44·06	18	40·4	+4 39 22·78			
Sept. 12	20	5·9	26 2·17	20	33·4	3 2·14	20	29·1	11·67	19	30·8	47·78	20	5·8	25·21			
Sept. 13	19	49·4	7·25	20	15·9	6·48	20	12·2	12·44	19	15·2	52·83	19	50·1	27·27			
	2	33·9	[27 5·50*]	3	25·8	7·84	2	55·4	12·65	1	57·0	54·28	2	43·6	28·31			
	2	44·9	26 6·46	3	31·5	[3·92*]	3	5·1	12·57	2	6·2	54·28	2	46·7	[31·79*]			
	10	13·9	6·02	10	40·2	9·48	10	34·9	13·19	9	36·0	[57·88*]	10	11·8	28·67			
Sept. 13	19	12·5	6·99	19	38·0	11·27	19	32·7	13·49	18	38·4	57·44	19	11·9	29·61			
„ 14	2	51·3	7·17	3	18·2	12·70	3	21·7	13·49	2	36·0	58·56	3	25·4	30·13			
Sept. 14	18	52·4	6·09	19	17·5	[11·24*]	19	13·2	13·30	18	16·9	11 0·06	18	55·2	30·95			
Sept. 22	19	37·5	+4 26 4·13	20	2·0	+4 3 43·48	19	57·8	+4 10 12·62	18	59·8	+5 11 21·11	19	34·2	+4 39 42·16			
	13	39·4	2·81	13	59·2	46·23	13	47·0	12·16	12	48·9	23·16	13	21·6	42·98			
	13	41·9	2·63	14	11·5	46·23	14	8·5	12·17	13	10·2	23·20	13	31·0	42·97			
	17	41·5	2·77	18	9·6	47·13	18	7·0	12·52	16	58·7	24·17	17	40·9	43·47			

[*] Discordant ; not used.

Carrying Time on board H.M.S. 'Shearwater.'

On both occasions when the 'Shearwater' arrived at Rodriguez, the five mean-time chronometers of which the errors have just been stated were carried on board, and all repeatedly compared by the intervention of the sidereal chronometer '43 with one or two mean-time chronometers, which were then compared with the whole of the chronometers brought from Mauritius.

1874, *September* 13.—We have first of all the following corrections of (43) to local sidereal time derived from each of the five Rodriguez chronometers :—

By chronometer	Epoch by (43)		Correction of (43) to local sidereal time			Epoch by (43)		Correction of (43) to local sidereal time			Epoch by (43)		Correction of (43) to local sidereal time		
	h.	m.	h.	m.	s.	h.	m.	h.	m.	s.	h.	m.	h.	m.	s.
'Parkinson and Frodsham'	16	46·4	+4	28	39·59	18	49·6	+4	28	39·65	20	29·7	+4	28	39·95
„ „	16	55·8			39·71	...			...		20	40·7			39·95
'Cotterell'	[16	37·5]			[39·14*]	18	57·0			40·01	[20	30·3]		[37	40·16*]
„	16	49·8			39·69	...			...		20	42·1		28	40·13
'Hewitt'	16	44·0			39·69	18	58·8			39·95	20	30·8			40·13
„	[16	51·4]		[27	39·74*]	...			...		20	46·2			40·17
'Carter'	16	44·8		28	39·78	[18	48·4]			[38·92*]	20	33·8			40·01
„	16	53·9			39·79	...			...		20	49·1			40·07
'Barraud'	[16	40·8		[30	40·11*]	[18	46·5]		[26	40·15*]	[20	37·3]		[29	40·38*]
„	[16	45·7]		[28	40·09*]	...			...		[20	43·3]		[29	39·37*]

[*] Discordant ; rejected.

Rejecting the results by 'Barraud' and the other numbers in brackets, we obtain as corrections of chronometer 43 to local sidereal time reduced to three epochs :—

	h. m.		h. m. s.
At	16 48·6	by (43), correction of (43) to Rodriguez sidereal time	+4 28 39·70
„	18 55·1	„ „ „ „	39·87
„	20 39·3	„ „ „ „	40·07

Finally, using these corrections of (43), we have the following corrections for 'Hewitt' at about the same epochs between which 'Hewitt' was compared with all the longitude chronometers :[2]—

	h. m.		h. m. s.
At	5 32·4	by 'Hewitt,' correction of 'Hewitt' to Rodriguez mean time . . .	+4 10 12·81
„	7 46·8	„ „ „ „ . . .	12·91
„	9 26·1	„ „ „ „ . . .	13·015

1874, *September* 22.—In the same way as on September 13, from the comparisons with the Rodriguez chronometers, we get the following corrections of chronometer 43 :—

By chronometer	Epoch by (43)	Correction of (43) to local sidereal time	By chronometer	Epoch by (43)	Correction of (43) to local sidereal time
	h. m.	h. m. s.		h. m.	h. m. s.
'Parkinson and Frodsham'	3 39·4	+4 28 55·71	'Parkinson and Frodsham'	4 54·4	+4 28 55·96
'Cotterell'	3 44·8	55·885	'Cotterell'	4 51·9	56·00
'Hewitt'	3 40·8	56·02	'Hewitt'	4 48·1	56·14
'Carter'	3 45·6	55·89	'Carter'	4 48·8	56·01
'Barraud'	3 42·5	55·92	'Barraud'	4 47·5	55·96

	h. m.		h. m. s.
Or at	3 42·6	by chronometer 43, correction of (43) to Rodriguez sidereal time .	+4 28 55·885
„	4 50·1	„ „ „ „ .	56·01

Whence the subjoined corrections of (36) and (4), with which all the chronometers were compared :—

	h. m.		h. m. s.
At	15 37·8	by chronometer 36, correction of (36) to Rodriguez mean time . .	+4 9 13·68
„	16 11·2	„ „ „ „ . .	13·77

	h. m.		h. m. s.
At	16 23·8	by chronometer 4, correction of (4) to Rodriguez mean time . . .	+4 5 45·78
„	16 50·9	„ „ „ „ .	45·89

The next page contains the comparisons of 'Hewitt,' (36), and (4) with the chronometers on board the 'Shearwater' at Rodriguez. The comparisons with 'Barraud' are omitted for the reasons given.

[2] The chronometers were also compared with 'Barraud,' but, as will be seen, the correction of this chronometer is so doubtful that it was impossible to use it.

Operations at Rodriguez.

Comparisons of Chronometers sent from Pamplemousses.

Rotation No.	1874, Sept. 13								1874, Sept. 22							
	Chronometer 'Hewitt;' Mr. Burton								Chronometer 36; Captain Wharton				Chronometer 4; Lieutenant Langdon			
	First Comparison				Second Comparison											
	Time by 'Hewitt'			Time by compared chronometer			Time by 'Hewitt'			Time by compared chronometer			Time by (36)			Seconds of compared chronometer	Time by (4)			Time by compared chronometer		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	s.	h.	m.	s.	h.	m.	s.
1	6	58	9·1	6	59	9·0	6	58	30·0	6	59	29·8	15	40	0	12·4	16	25	0	16	21	44·5
2	6	56	50·7	7	4	7·0	6	57	24·0	7	4	40·3		„		52·0		„		16	28	23·9
3	6	55	52·4	7	2	15·0	6	58	5·4	7	3	28·0		„		7·5		„		16	27	39·45
4	6	53	0·2	6	57	8·2	6	53	49·7	6	57	56·0		...		...		...			...	
7	6	50	52·6	6	58	31·0	6	51	16·0	6	58	54·4		„		20·6	16	26	0	16	29	52·8
8	6	45	16·0	6	46	34·6	6	45	51·4	6	47	10·0		„		40·55		„		16	23	12·4
9	6	43	29·6	6	45	36·0	6	44	5·7	6	46	12·0		„		31·4		„		16	24	3·45
10	6	41	22·5	6	47	2·0	6	42	32·5	6	48	12·0		„		9·0		„		16	27	40·95
11	6	39	54·6	6	49	7·0	6	41	4·6	6	51	17·0		„		7·3	16	27	0	16	33	39·45
12	6	37	3·8	6	32	59·0	6	38	3·8	6	33	59·0	15	45	0	53·25	16	28	0	16	19	25·4
13	6	36	3·3	6	31	31·0	6	37	3·3	6	32	31·0		„		31·0		„		16	19	2·95
14	6	34	45·7	6	33	40·0	8	21	50·0	8	20	43·8		„		1·25		„		16	22	33·4
15	6	33	25·7	6	29	46·0	8	19	8·0	8	15	28·2		„		46·75	16	29	0	16	21	18·9
16	6	32	42·4	6	31	50·0	8	18	20·0	8	17	27·8		„		39·5		„		16	24	11·55
17	6	31	9·4	6	39	15·0	8	17	19·0	8	25	24·5		„		40·85		„		16	33	12·95
18	6	29	15·0	6	40	15·0	8	15	40·0	8	26	40·1		„		22·5		„		16	35	54·45
19	6	28	19·0	6	25	2·7	8	14	30·0	8	11	13·8		„		41·3		„		16	21	13·5
20	6	23	27·5	6	30	16·1	8	12	50·0	8	19	38·8		„		44·75		„		16	52	17·0
21	6	24	37·0	6	25	50·0	8	11	30·0	8	12	42·8	15	50	0	36·25	16	32	0	16	39	8·45
22	6	26	38·0	6	29	52·7	8	10	15·0	8	13	30·0		„		21·75		„		16	30	53·9
23	6	22	1·4	6	24	12·0	8	5	19·7	8	7	30·0		„		25·7		„		16	29	57·9
24	6	20	50·0	6	23	5·4	8	0	47·8	8	3	5·0		„		51·3	16	33	0	16	31	23·55
25	6	18	44·4	6	18	30·0	7	58	29·4	7	58	14·0		„		9·75		„		16	28	42·05
26	6	17	31·3	6	3	32·0	7	56	53·7	7	42	54·0		„		38·45		„		16	14	10·5
27	6	16	33·9	6	3	9·0	7	53	58·9	7	40	34·0		„		26·5		„		16	14	58·4
28	6	15	33·1	6	13	23·5	7	52	28·0	7	51	18·6		„		49·45		„		16	26	21·55
29	6	14	44·6	6	7	57·0	7	48	54·0	7	42	5·8		„		6·3		„		16	21	38·5
36	6	13	3·4	6	13	43·0	7	43	5·9	7	43	46·0		...		...		...			...	
37	6	12	5·6	6	10	10·1	7	40	9·4	7	38	15·0	15	55	0	19·1	16	36	0	16	29	51·0
38	6	10	58·4	6	24	57·0	7	38	44·0	7	51	42·5		„		29·5		„		16	45	1·45
39	6	10	10·4	6	26	3·0	7	37	40·0	7	33	32·4		„		50·25		„		16	48	22·45
40	6	8	37·0	6	10	52·3	7	30	8·5	7	32	25·0		„		44·15		„		16	34	16·5
42	6	6	48·5	6	4	18·1	7	27	18·4	7	24	48·0		„		36·5		„		16	29	8·4
44	6	1	56·4	5	55	50·0	7	25	25·2	7	19	18·5	16	0	0	57·0	16	39	0	16	28	28·9
45	6	3	9·2	5	51	17·5	7	24	51·6	7	12	0·0		„		58·75		„		16	22	30·9
46	5	57	6·5	6	4	50·1	7	22	11·0	7	28	55·0		„		50·6	16	40	0	16	43	22·45
47	5	56	37·5	5	19	39·1	7	19	47·8	7	43	9·0		„		47·7		„		16	57	19·45
48	5	55	42·0	10	50	30·2	7	16	58·0	12	11	46·1		„		23·45		„		16	29	55·5
49	5	54	20·1	5	54	35·0	7	15	8·0	7	15	23·4		„		58·6		„		16	36	30·9
51	5	52	24·0	5	46	18·1	7	11	36·8	7	6	1·0		„		16·7		„		16	29	48·8
52	5	49	51·1	5	28	54·5		...			...			„		3·6		„		16	14	35·9
A		...			...			...			...		16	6	0	45·1	16	45	0	18	49	17·05
B		...			...			...			...			„		30·8		„		16	13	2·8
D		...			...			...			...			„		26·7		„		17	42	58·8
F		...			...			...			...			„		35·1		„		14	39	6·95
G		...			...			...			...			„		50·5		„		16	45	22·4
H		...			...			...			...			„		31·0		„		16	29	3·0

From the comparisons just given we derive the corrections of the longitude chronometers to Rodriguez time, and, bringing over the calculated corrections to Pamplemousses time given on p. 93, we have immediately the differences of longitude by each chronometer as shown in the following tables :—

Rotation No.	First Run. 1874, September 13				
	Chronometer correction to Rodriguez time. First comparison	Chronometer correction to Rodriguez time. Second comparison	Seconds of mean	Corresponding correction to Pamplemousses time	Resulting longitude, Rodriguez east of Pamplemousses
	h. m. s.	h. m. s.	s.	h. m. s.	h. m. s.
1	+4 9 12·97	+4 9 13·07	13·02	+3 45 42·91	0 23 30·11
2	4 2 56·57	4 2 56·57	56·57	3 39 26·57	30·00
3	4 3 50·27	4 3* 50·27	50·27	3 40 19·86	30·41
4	4 6 [4·87†]	4 6 6·57	6·57	3 42 36·36	30·21
7	4 2 34·47	4 2 34·47	34·47	3 39 4·46	30·01
8	4 8 54·26	4 8 54·26	54·26	3 45 24·32	29·94
9	4 8 6·46	4 8 6·56	6·51	3 44 36·58	29·93
10	4 4 33·36	4 4 33·36	33·36	3 41 3·55	29·81
11	4 0* 0·46	4 0 0·46	0·46	3 36 30·87	29·59
12	4 14 17·66	4 14 17·66	17·66	3 50 47·34	30·32
13	4 14 45·16	4 14 45·16	45·16	3 51 14·78	30·38
14	4 11 18·56	4 11 19·15	18·85	3 47 48·79	30·06
15	4 13 52·56	4 13 52·74	52·65	3 50 22·49	30·16
16	4 11 5·25	4 11 5·14	5·19	3 47 35·04	30·15
17	4 2 7·25	4 2 7·44	7·35	3 38 36·95	30·40
18	3 59 12·85	3 59 12·84	12·85	3 35 42·59	30·26
19	4 13 29·15	4 13 29·14	29·15	3 49 58·91	30·24
20	4 3 24·25	4 3 24·14	24·19	3 39 - 54·25	29·94
21	4 8 59·85	4 9 0·14	59·99]	3 45 29·78	30·21
22	4 6 58·15	4 6 57·93	58·04	3 43 27·36	30·68
23	4 8 2·25	4 8 2·63	2·44	3 44 31·55	30·89
24	4 7 57·45	4 7 55·72	56·59	3 44 25·13	31·46
25	4 10 [27·24†]	4 10 28·32	28·32	3 46 57·90	30·42
26	4 24 12·14	4 24 12·62	12·38	4 0 42·87	29·51
27	4 23 37·74	4 23 37·82	37·78	4 0 7·08	30·70
28	4 12 22·44	4 12* 22·32	22·38	3 48 51·76	30·62
29	4 17 0·44	4 17 1·11	0·77	3 53 30·65	30·12
36	4 9 33·24	4 9 32·81	33·03	3 46 3·33	29·70
37	4 12 [8·34†]	4 12 7·30	7·30	3 48 36·96	30·34
38	3 56* 14·24	3 57 14·40	14·32	3 33 43·76	30·56
39	3 54 20·24	3 54* 20·50	20·37	3 30 46·18	[34·19†]
40	4 7 [57·54†]	4 7 56·40	56·40	3 44 25·78	30·62
42	4 12 43·24	4 12 43·30	43·27	3 49 13·04	30·23
43	4 28 ...	4 28 ...	39·88	4 5 8·96	30·92
44	4 16 19·24	4 16 19·59	19·41	3 52 51·17	[28·24†]
45	4 22 4·53	4 22* 4·49	4·51	3 58 33·93	30·58
46	4 3* 29·23	4 3 28·89	29·06	3 39 59·30	29·76
47	3 46 51·23	4 46 51·69	51·46	4 23 23·52	[27·94†]
48	23 15 24·63	4 15 24·79	24·71	4 6 28·50	... ...
49	4 9 57·93	4 9 57·49	57·71	3 46 31·37	[26·34†]
51	4 15 48·72	4 15 48·68	48·70	3 52 17·77	30·93
52	4 31 9·42	...	9·42	4 7 39·96	29·46

* One of the original comparisons assumed one minute wrong.

[†] Discordant ; rejected.

Rotation No.	1874, September 22				
	Seconds of chronometer correction to Rodriguez time by (36)	Chronometer correction to Rodriguez time by (4)	Seconds of mean	Corresponding correction to Pamplemousses time	Resulting longitude, Rodriguez east of Pamplemousses
	s.	h. m. s.	s.	h. m. s.	h. m. s.
1	+ 1·29	+4 9 1·29	1·29	+3 45 31·35	0 23 29·94
2	21·69	4 2 21·88	21·79	3 38 51·55	30·24
3	6·19	4 3 6·32	6·26	3 39 36·18	30·08
4	...	4 5 ...	45·84	3 42 15·95	29·89
7	53·09	4 1 52·99	53·04	3 38 23·37	29·67
8	33·14	4 8 33·39	33·27	3 45 3·25	30·02
9	42·29	4 7 42·34	42·31	3 44 12·05	30·26
10	4·69	4 4 4·84	4·77	3 40 34·24	30·53
11	6·39	3 59 6·34	6·37	3 35 36·27	30·10
12	20·45	4 14 20·40	20·43	3 50 50·22	30·21
13	42·70	4 14 42·85	42·77	3 51 12·36	30·41
14	12·45	4 11 12·40	12·43	3 47 42·29	30·14
15	26·95	4 13 26·90	26·93	3 49 56·75	30·18
16	34·20	4 10 34·25	34·23	3 47 4·33	29·90
17	32·85	4 1 32·85	32·85	3 38 2·66	30·19
18	51·20	3 58 51·35	51·27	3 35 21·33	29·94
19	32·40	4 13 32·30	32·35	3 50 2·47	29·88
20	28·95	4 2 28·80	28·87	3 38 58·94	29·93
21	37·46	4 8 37·37	37·41	3 45 7·27	30·14
22	51·96	4 6 51·92	51·94	3 43 21·92	30·02
23	48·01	4 7 47·92	47·97	3 44 18·39	29·58
24	22·41	4 7 22·27	22·34	3 43 52·25	30·09
25	3·96	4 10 3·77	3·87	3 46 33·91	29·96
26	35·26	4 24 35·32	35·29	4 1 5·16	30·13
27	47·21	4 23 47·42	47·31	4 0 16·96	30·35
28	24·26	4 12 24·27	24·27	3 48 54·31	29·96
29	7·41	4 17 7·32	7·37	3 53 37·17	30·20
36	...	4 9 ...	13·73	3 45 43·75	29·98
37	54·63	4 11 54·83	54·73	3 48 25·05	29·68
38	44·23	3 56 44·38	44·31	3 33 14·33	29·98
39	23·48	3 53 23·38	23·43	3 29 51·24	[32·19*]
40	29·58	4 7 29·33	29·45	3 43 59·49	29·96
42	37·23	4 12 37·43	37·33	3 49 7·08	30·25
43	...	4 28 ...	55·95	4 5 25·73	30·22
44	16·74	4 16 16·94	16·84	3 52 46·69	30·15
45	14·99	4 22 14·94	14·97	3 58 45·19	29·78
46	23·14	4 2 23·40	23·27	3 38 53·48	29·79
47	26·04	4 48 26·40	26·22	4 24 56·25	29·97
48	50·29	11 15 50·35	50·32	4 7 21·58	... ...
49	15·14	4 9 14·95	15·05	3 45 44·05	[31·00*]
51	57·04	4 15 57·05	57·05	3 52 27·51	29·54
52	10·14	4 31 9·95	10·05	4 7 40·25	29·80
A	28·66	2 1 28·82	28·74	1 37 58·33	30·41
B	42·96	4 37 43·07	43·01	4 14 12·93	30·08
D	47·06	3 7 47·07	47·07	2 44 16·65	30·42
F	38·66	6 11 38·92	38·79	10 47 8·49	30·30
G	23·26	4 5 23·47	23·37	3 41 53·83	29·54
H	42·76	4 21 42·87	42·81	3 58 13·87	[28·94*]

[*] Discordant; rejected.

The runs being so short and the rates having been derived from the going of the chronometers during the voyages, it seemed useless to classify the chronometers according to their degrees of excellence. A mean of all the results for each run was therefore taken, excluding only a few of the chronometers that gave obviously erroneous results. In this way we find :—

	h.	m.	s.	s.
First run, from 37 chronometers, Rodriguez east of Pamplemousses . .	0	23	30·26	±0·05
Second run, „ 44 „ „ „ „ . .			30·04	±0·02

On the first run the comparisons with the sidereal clock at Rodriguez were made about three hours from the time determinations, but on the second run an interval of twelve hours elapsed. On this account it would be unsafe to combine the results with regard only to their probable errors ; it is preferable to give weights in proportion to the number of chronometers used. This gives—

	h.	m.	s.	s.
Rodriguez east of Pamplemousses	0	23	30·14	±0·030
Personal equation between Lieutenant Neate and Mr. Gill in observing transits *			+0·50	±0·103

We have still to consider various other sources of error. These are—

	Probable error s.	s.
a. The probable error of the time at Rodriguez—		
From 35 stars, this is found to be, for 1 star	±0·095	
Of a time determination by 5 stars	±0·042	
Of the mean of two time determinations, one for each run	...	±0·030
b. The probable error of the time at Pamplemousses—		
From 30 stars, for 1 star	±0·076	
Of a time determination by 5 stars	±0·034	
Of the mean of four time determinations, one before and after each run . .	...	±0·017
c. Of carrying the time on board at Rodriguez for two runs	...	±0·022
d. Of carrying the time on board at Pamplemousses, where for one chronometer the error was ±0ˢ·075, or with six chronometers taken four times . .	...	±0·015
e.† For the variation of the rate of the sidereal clock at Rodriguez, assumed at ±0ˢ·01 per hour ; for two runs	...	±0·046

Or as final result—

	h.	m.	s.	s.
Rodriguez east of Pamplemousses	0	23	30·64	±0·13

* See Chapter V.

† At Pamplemousses the transmitting chronometers were always compared at the time of observation ; therefore all error arising from this source i included in that of carrying the time on board.

CHAPTER IV.

DETERMINATION OF THE DIFFERENCE OF LONGITUDE BETWEEN BELMONT AND SOLITUDE BY THE TRANSPORT OF CHRONOMETERS AND BY TELEGRAPHIC SIGNALS.

In addition to what has already been stated respecting this operation in the 'Introduction to the Longitudes' little remains to be said. The time at Solitude was found by Drs. Löw and Pechüle observing with their portable transit instrument, which is briefly described below. Dr. Löw's results were corrected for personal equation to reduce them to Dr. Pechüle's, who afterwards determined personal equation with Mr. Gill and Dr. Copeland. At Belmont the time was found by Dr. Copeland with the reversing transit instrument, of which observations the necessary results only are given here, the details being reserved for Volume IV.

The Transit Instrument of the German Expedition to Mauritius.

This instrument is called by us 'Dr. Löw's transit instrument;' it is one of a number of similar instruments, two of which were originally made for the Geodetical Institution of Berlin, and a third for Professor Kaiser at Leyden.

The following general description is taken chiefly from pages 8 and 9 of the 'Astronomisch-geodätische Arbeiten im Jahre 1870,' 4to., Leipzig, 1871.

The rectangular base is 73^{cm} by 27^{cm}, and carries two iron supports for the Y's. There are three foot screws for adjustment in accordance with the indications of an attached level. On one side of the base, movable by a screw, is a slide carrying two of the foot screws; by this slide the adjustment in azimuth is effected.

The 'broken' telescope has an aperture of 68^{mm} and a focal length of 870^{mm}. The eye-piece is at one end of the pierced axis, while the light for illuminating the field of view enters centrally through the opposite end. At the eye-end is a small setting circle. The effective length of the axis is 63^{cm}. The pivots are 41^{mm} in diameter. Two eye-pieces afford magnifying powers of about 60 and 90 times. The tube, 38^{cm} long, which carries the object glass is of course counterbalanced. The hanging level for finding the inclination can remain in position while the observations are being made, so that it can be read off at all times. The value of one part of the level is stated by Dr. Löw to be $0^{s}\cdot111$, and the inequality of pivots—

$$\text{Circle pivot} - \text{lamp pivot} = -0^{p}\cdot60.$$

Assuming the Y's of the stand and level to be rectangular, the corrections to the *immediate results* of the level readings are $+0^{p}\cdot15$ for Circle West and $-0^{p}\cdot15$ for Circle East. In the

field of view are eleven fixed wires ; their intervals from wire VI., derived from the observations at Suez and Malta, are, for Circle West, upper culmination :—

	Mean time s.		Mean time s.
I.	36·170	VII.	8·040
II.	24·109	VIII.	11·943
III.	16·048	IX.	16·027
IV.	12·066	X.	24·078
V.	8·072	XI.	36·163

There is also one wire movable by a micrometer screw. Professor Auwers found the value of one revolution of this screw to be $4^{s}\cdot020$. The head of the screw is divided into 100 parts.

A separate stand seems to have been used for the lamp.

Belmont-Solitude Longitude.

Comparison of Chronometers at Solitude.

1874, December 21.

Nieberg			Normal clock		
h.	m.	s.	h.	m.	s.
7	0	15·5	0	58	10·0
8	46	0·0	2	44	12·0
11	36	45·0	5	35	25·0

1874, December 22.

Nieberg			Normal clock		
h.	m.	s.	h.	m.	s.
5	39	30·5	23	41	9·0
9	14	51·0	3	17	5·0
12	40	40·0	6	43	28·0

Normal clock			(36)		
h.	m.	s.	h.	m.	s.
3	33	27·0	5	49	35·5
4	53	55·0	7	9	50·5

Normal clock			Reid		
h.	m.	s.	h.	m.	s.
3	20	54·0	9	17	52·0
4	57	24·0	10	54	6·0

1874, December 23.

Nieberg			Normal clock		
h.	m.	s.	h.	m.	s.
5	24	10·5	23	29	44·0
9	14	5·5*	3	20	17·0
[19	50	55·0	13	54	2·0†]

Normal clock			(36)		
h.	m.	s.	h.	m.	s.
14	1	53·0	16‡	16	20·0
15	21	26·0	17§	35	40·0

Normal clock			Reid		
h.	m.	s.	h.	m.	s.
13	57	38·0	19	52	50·5

* 9^{h} 14^{m} 55^{s} in Dun Echt copy. [†] This comparison is wrong and cannot be used. ‡ 20^{h} in original.
§ 21^{h} in original.

Time Determinations at Solitude.

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVERS, DR. LÖW AND DR. PECHÜLE; CHRONOMETER NIEBERG.

Date, 1874	Observer	Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of transit over wire VI.			Level readings	
				I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.					
				s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Dec. 21	P	α Arietis	W	...	...	...	...	...	20·3	28·7	33·4	37·8	46·5	59·6	7	59*	20·31	+ 11·3	− 11·7
																		+ 9·3	− 13·7
																		+ 9·8	− 14·1
	,,	67 Ceti	,,	19·2	31·2	...	43·3	...	55·6	...	7·6	...	19·8	32·0	8	9	55·55	+ 12·1	− 11·8
	,,	z Oct. S.P.	,,	...	...	...	...	...	...	...	18·0	40·0	...	...	8	28	7·04	...	...
	,,	,,	E	...	...	...	...	...	12·0	25·0	59·0	39·5	...	...			11·28	+ 11·8	− 12·1
																		+ 13·9	− 10·3
	,,	33 Tauri	,,	13·3	0·4	51·4	47·2	42·7	34·2	25·4	21·2	16·6	8·1	54·8	9	48	34·10	...	...
	,,	γ^1 Eridani	,,	43·0	30·7	...	18·3	...	5·8	...	53·5	...	41·2	...	9	51	5·85	+ 12·3	− 12·1
																		+ 12·6	− 12·0
	,,	χ Tauri	,,	29·5†	16·2	7·2	2·7	58·4	49·4	40·4	36·3	31·6	22·7	9·4	10	13	49·42	...	...
	,,	α Tauri	,,	11·0	58·5	...	45·8‡	...	33·4	...	20·7	...	8·2	55·6	10	27	33·29	...	...
	,,	B.A.C. 1746	,,	24·8	11·2	...	57·5	...	43·9	...	30·2	...	16·9	3·2	11	26	43·93	+ 12·1	− 13·0
																		+ 14·2	− 11·0
Dec. 22	P	α Androm.	E	10·2	56·3	...	42·7	...	29·1	...	15·3	...	1·6	47·8	§5	57	28·97	+ 12·9	− 7·0
																		+ 10·0	− 10·3
																		+ 9·3	− 11·5
	,,	γ Pegasi	,,	57·6	45·3	...	32·9	...	...	...	...	...	...	...	6	2	20·36	+ 15·8	− 3·2
																		+ 10·4	− 10·6
	,,	β Hydri	,,	...	...	..	...	...	...	...	40·0	20·2	41·7	43·5	6	14	37·12	+ 15·8	− 5·3
																		+ 8·0	− 13·9
	,,	β Ceti	W	8·3	21·2	...	33·7	...	46·5	...	59·2	...	11·8	24·7	6	32	46·51	+ 14·2	− 7·7
																		+ 19·0	− 20·7
	L	17 Tauri	W	...	0·5	...	13·4	...	26·4	...	39·6	...	53·4	6·5	9	32	26·74	+ 42·2	− 44·1
																		+ 18·1	− 21·0
	,,	ζ Persei	,,	32·4	46·4	...	0·8	...	15·1	...	29·2	...	43·4	57·5	9	41	15·00	+ 41·8	− 44·5
																		+ 17·7	− 19·8
	,,	γ^1 Eridani	,,	31·3	44·0	...	56·2	...	8·8	...	21·2	...	33·5	46·2	9	47	8·77	+ 41·4	− 43·7
	,,	Lac. 1592	,,	...	...	...	...	...	58·0	...	...	...	15·0	53·5	10	0	58·71	...	...
	,,	ϵ Tauri	,,	...	...	...	...	...	10·7	...	23·4	...	36·5	49·1	§10	16	10·85	[+ 21·6‖	− 17·4]
																		+ 45·7	− 41·4
	,,	α Tauri	,,	58·0	10·4	...	23·2	...	35·9	...	48·2	..	1·0	13·2	10	23	35·72	...	...
	,,	μ Eridani	,,	28·2	40·1	...	52·2	...	4·2	...	16·3	...	28·2	...	10	34	4·26	+ 16·7	− 17·9
																		+ 40·9	− 42·0
	,,	π^4 Orionis	,,	44·8	56·9	...	9·2	...	21·2	...	33·1	...	45·4	57·5	10	39	21·18	...	...
	,,	B.A.C. 1648	,,	11·4	25·3	...	39·2	...	52·3	...	6·2	...	19·4	33·3	11	7¶	52·47	+ 17·0	− 17·0
																		+ 41·3	− 41·6
																		+ 16·2	− 16·9
	,,	β Tauri	,,	...	39·2	...	52·8	...	6·3	...	20·1	...	33·5	47·8	11	13**	6·45	+ 40·7	− 41·2
																		+ 16·9	− 17·0
																		+ 41·4	− 41·5
	,,	Lac. 2512	,,	[50·0‖]	...	...	...	...	25·5	17·0	10·5	9·0	1·8	...	12	7	23·72	+ 17·8	− 18·8
																		+ 42·3	− 43·3
Dec. 23	L	θ Ceti	W	33·1	46·2	...	58·1	...	10·4	...	22·2	...	34·2	47·2	7	9	10·22	+ 18·1	− 19·9
																		+ 41·1	− 42·7
	,,	67 Ceti	,,	23·3	35·8	...	48·3	...	0·2	...	12·2	...	24·4	36·5	8	2	0·12	+ 16·8	− 17·0
																		+ 40·2	− 40·6
	,,	Lac. 1029	,,	35·0	42·5	43·0	46·5	46·8	...	...	...	...	...	...	8	30	51·60	+ 16·2	− 16·9
																		+ 40·0	− 40·8
	,,	,,	E	6·0	0·7	56·8	55·0	54·5	...	...	...	...	...	...			49·76	+ 15·0	− 16·5
																		+ 39·0	− 40·6
	,,	α Ceti	,,	29·2	16·8	...	4·3	...	52·5	...	40·7	...	28·7	16·1	8	46	52·59	+ 15·2	− 15·7
																		+ 39·2	− 39·7
	,,	δ Arietis	,,	...	1·2	..	48·4	...	35·4	...	23·1	...	10·0	57·2	8	55	35·57	+ 16·2	− 15·2
																		+ 40·4	− 39·3

* 58m in original.
† 27s·5 in original.
‡ 55s·8 in original.

§ Hours and minutes assumed.
[‖ Discordant; rejected.
¶ 8m in original.
** 14m in original.

Collimation, 1874, Dec. 22

Circle West		Circle East	
Mer. mark	Mid. wire	Mer. mark	Mid. wire
r.	r.	r.	r.
72·5	82·7	92·2	83·6
72·5	82·4	91·7	83·4
72·2	82·8	92·7	83·5
72·9	82·7	92·2	83·1

These observations yield the instrumental corrections :—

Date, 1874	Level E.	Level W.	Collimation Circle W.	Azimuth
	s.	s.	s.	s.
Dec. 21 . . .	−0·014	−0·048	−0·083	+1·046
„ 22 1st group .	+0·186	+0·153	−0·028 (collimator)*	+1·125
„ 22 2nd group .	...	−0·051	„ „	+1·070
„ 23 . . .	−0·019	−0·052	−0·053	+1·020

Bringing forward the 'Concluded time of transit over wire VI.' and applying the necessary corrections, we obtain the chronometer correction from each star observed.

Observers, Dr. Löw and Dr. Pechüle ; chronometer, Nieberg :—

Date, 1874	Epoch by chronometer and assumed hourly rate	Observer	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Chronometer rate to epoch	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m. s.				h. m. s.	s.	s.	h. m. s.	h. m. s.
Dec. 21	9 11 0	P	α Arietis	W	7 59 20·31	−11·77	− 0·91	2 0 7·84	−5 59 59·79
	s.								
	+9·856	„	67 Ceti	„	8 9 55·55	−10·03	− 0·37	2 10 45·35	59·80
		„	ε Oct. S.P.	„	8 28 7·04	− 7·04	−21·67	14 28 38·65	
		„	„	E	11·28	− 7·03	−25·92	„	[59·68]
		„	33 Tauri	„	9 48 34·10	+ 6·17	− 0·70	3 49 40·03	59·54
		„	γ^1 Eridani	„	9 51 5·85	+ 6·59	− 0·04	3 52 12·70	59·70
		„	χ Tauri	„	10 13 49·42	+10·32	− 0·75	4 14 59·33	59·66
		„	α Tauri	„	10 27 33·29	+12·58	− 0·57	4 28 45·65	59·62
		„	B.A.C. 1746	„	11 26 43·93	+22·30	− 0·80	5 28 5·81	59·62
	h. m. s.								
Dec. 22	6 16 0	P	α Androm.	E	5 57 28·97	− 3·04	− 0·79	0 1 55·02	−5 55 30·12
	s.								
	+9·856	„	γ Pegasi	„	6 2 20·36	− 2·24	− 0·47	0 6 47·48	30·17
		„	β Hydri	„	6 14 37·12	− 0·23	+ 5·17	0 19 11·75	[30·31]
		„	β Ceti	W	6 32 46·51	+ 2·76	+ 0·09	0 37 18·74	30·62
	h. m. s.								
Dec. 22	10 22 0	L	17 Tauri	W	9 32 26·74	− 8·14	− 0·88	3 37 27·85	−5 54 49·87
	s.								
	+9·856	„	ζ Persei	„	9 41 15·00	− 6·69	− 1·06	3 46 17·26	49·99
		„	γ^1 Eridani	„	9 47 8·77	− 5·73	− 0·21	3 52 12·67	50·16
		„	Lac. 1592	„	10 0 58·71	− 3·45	+12·09	4 6 17·84	[49·51]
		„	ε Tauri	„	10 16 10·85	− 0·96	− 0·79	4 21 19·83	49·27
		„	α Tauri	„	10 23 35·72	+ 0·26	− 0·73	4 28 45·68	49·57
		„	μ Eridani	„	10 34 4·26	+ 1·98	− 0·39	4 39 16·08	49·77
		„	π^4 Orionis	„	10 39 21·18	+ 2·85	− 0·55	4 44 33·75	49·73
		„	B.A.C. 1648	„	11 7 52·47	+ 7·54	− 0·97	5 13 9·46	49·58
		„	β Tauri	„	11 13 6·45	+ 8·40	− 0·99	5 18 24·36	49·50
		„	Lac. 2512	„	12 7 23·72	+17·31	+13·00	6 13 4·11	[49·92]
	h. m. s.								
Dec. 23	8 13 0	L	θ Ceti	W	7 9 10·22	−10·49	− 0·31	1 17 46·63	−5 51 12·79
	s.								
	+9·856	„	67 Ceti	„	8 2 0·12	− 1·81	− 0·34	2 10 45·27	12·70
		„	Lac. 1029	„	8 30 57·60	+ 2·93	+13·17	2 39 55·07	
		„	„	E	49·76	+ 2·92	+15·02	„	[12·65]
		„	α Ceti	„	8 46 52·59	+ 5·57	− 0·39	2 55 45·22	12·55
		„	δ Arietis	„	8 55 35·57	+ 7·00	− 0·65	3 4 29·36	12·56

* The *sign* of this value for collimation has been assumed.

Taking the means we get :—

Observer, Dr. Pechüle; Chronometer Nieberg.

Date	Epoch by chronometer	Chronometer correction to local sidereal time		Hourly rate
	h. m. s.	h. m. s.	h. m. s.	s.
1874, Dec. 21	9 11 0	Circle E. −5 58 59·630 „ W. 59·795	−5 58 59·71	+9·9288
„ „ 22	6 16 0	Circle E. −5 55 30·145 „ W. 30·620	−5 55 30·38	

Observer, Dr. Löw; Chronometer Nieberg.

Date	Epoch by chronometer	Chronometer correction to local sidereal time		Hourly rate
	h. m. s.	h. m. s.	h. m. s.	s.
1874, Dec. 22	10 22 0	Circle W.	−5 54 49·71	+9·9341
„ „ 23	8 13 0	Circle E. −5 51 12·555 „ W. 12·745	−5 51 12·65	

Using these corrections and rates, the comparisons of Nieberg with the normal clock give the corrections of the normal clock as follows :—

Date	Epoch by clock	Correction to local sidereal time	Hourly rate
	h. m.	m. s.	s.
1874, Dec. 21	3 5·9	+2 44·24	+0·0408
„ „ 22	23 41·2	2 45·08	
„ „ 22	5 0·3	2 45·21	+0·0360
„ „ 23	1 25·0	2 45·98	

Bringing the observations of Dr. Löw and Dr. Pechüle to a common epoch, we derive for difference of personal equation :—

	s.
Dr. Löw–Dr. Pechüle by chronometer Nieberg	= −0·05
„ „ by normal clock	= −0·07
Therefore Dr. Löw–Dr. Pechüle	= −0·06

Reducing all the preceding chronometer corrections to Dr. Pechüle, who determined his difference of personal equation with Dr. Copeland, we have :—

	Chronometer Nieberg.			*Normal Clock.*		
Date	Epoch by chronometer	Correction	Hourly rate	Epoch by clock	Correction	Hourly rate
	h. m. s.	h. m. s.	s.	h. m.	m. s.	s.
1874, Dec. 21	9 11 0	−5 58 59·71	+9·9288	3 5·9	+2 44·24	+0·0408
„ „ 22	6 16 0	5 55 30·38		23 41·2	45·08	
„ „ 22	10 22 0	5 54 49·65	+9·9341	5 0·3	45·27	+0·0360
„ „ 23	8 13 0	5 51 12·59		1 25·0	46·04	

and then from the comparisons of the normal clock with the chronometers 36 and Reid the following corrections of these chronometers to local mean time :—

	Chronometer 36.		*Chronometer Reid.*	
Date	Epoch by chronometer	Correction	Epoch by chronometer	Correction
	h. m.	h. m. s.	h. m.	m. s.
1874, Dec. 22	5 49·6	+3 42 11·23	9 17·9	+1 23·78
	7 9·8	11·10	10 54·1	24·03
	16 16·3	10·14	19 52·8	25·33
	17 35·7	10·15		

COMPARISONS OF CHRONOMETERS WITH THE STANDARD (36).

1874, DECEMBER 22

Rotation No.	Time by (36)	Seconds of compared chronometer	Time by (36)*	Seconds of compared chronometer	Rotation No.	Time by (36)	Seconds of compared chronometer	Time by (36)*	Seconds of compared chronometer
	h. m. s.	s.	h. m. s.	s.		h. m. s.	s.	h. m. s.	s.
1	6 5 0	1·1	17 2 0	59·85	21	7 2 0	4·45	17 16 0	4·5
2	„	58·5	„	59·05	22	„	20·25	„	18·5
3	„	14·05	„	14·95	23	„	53·3	„	52·85
4	„	48·0	„	47·4	24	„	41·85	„	41·5
7	„	36·3	„	36·95	25	„	30·0	„	30·7
8	„	14·35	„	13·9	26	„	11·35	„	9·5
9	„	24·3	„	24·5	27	„	14·8	„	12·4
10	„	42·1	„	42·25	28	„	18·3	„	16·8†
11	„	44·1	„	45·8	29	„	32·8	„	30·9
12	6 53 0	4·3	16 48 0	2·75	30	6 27 0	1·0	16 29 0	2·9
13	„	28·75	„	27·45	32	„	51·45	„	49·95
14	„	54·25	„	52·5	33	„	5·85	„	4·8
15	„	9·15	„	8·5	34	„	3·3	„	1·95
16	„	25·25	„	24·8	35	„	20·35	„	19·5
17	„	44·3	„	44·95	37	„	7·2	„	8·5
18	„	53·2	„	52·5	42	„	9·85	„	8·45
19	„	4·8	„	3·45	50	„	37·1	„	36·35
20	„	51·8	„	53·5					

* The times in this column have all been decreased 4 hours. † 21°·8 in original.

These comparisons lead to the following corrections of the chronometers to Solitude mean time :—

1874, DECEMBER 22

Rotation No.	Chronometer correction	Chronometer correction	Rotation No.	Chronometer correction	Chronometer correction	Rotation No.	Chronometer correction	Chronometer correction
	s.	s.		s.	s.		s.	s.
1	+ 10·11	+ 10·30	15	+ 1·98	+ 1·64	27	+ 56·31	+ 57·75
2	12·71	11·10	16	45·88	45·34	28	52·81	53·35
3	57·16	55·20	17	26·83	25·19	29	38·31	39·25
4	23·21	22·75	18	17·93	17·64	30	10·17	7·24
7	34·91	33·20	19	6·33	6·69	32	19·72	20·19
8	56·86	56·25	20	19·33	16·64	33	5·32	5·34
9	46·91	45·65	21	6·66	5·65	34	7·87	8·19
10	29·11	27·90	22	50·86	51·65	35	50·82	50·64
11	27·11	24·35	23	17·81	17·30	37	3·97	1·64
12	6·83	7·39	24	29·26	28·65	42	1·32	1·69
13	42·38	42·69	25	41·11	39·45	50	34·07	33·79
14	16·88	17·64	26	59·76	0·65			

Signals sent to and received from Belmont.

The subjoined table contains the chronometer and Solitude sidereal times of the telegraphic signals sent to and received from Belmont. These times will be available for finding the difference of longitude as soon as we have deduced the corresponding Belmont times. The signals were sent and received by chronometer Reid, for the corrections of which see p. 116 :—

1874, December 22

Number of signal	Set 1		Set 2	
	Time by chronometer Reid	Solitude sidereal time of signals sent to Belmont	Time by chronometer Reid	Solitude sidereal time of signals received from Belmont
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	12 11 10·0	6 17 26·12	12 57 24·2	7 3 48·03
2	20·0	36·15	34·1	57·96
3	30·0	46·18	54·1	4 18·01
4	40·0	56·21	58 4·2	28·14
5	50·0	18 6·23	14·1	38·06
6	12 0·0	16·26	24·2	48·19
7	10·0	26·29	12 58 34·2	7 4 58·22
8	20·0	36·31		
9	30·0	46·34		
10	40·0	56·37		
11	50·0	19 6·40		
12	12 13 0·0	6 19 16·42		

Coincidences of chronometers were also telegraphed and noted at each end. The following are the chronometer and local sidereal times of the coincidences at Solitude :—

Coincidence sent to Belmont.

Time by chronometer Reid	Solitude sidereal time
h. m. s.	h. m. s.
12 15 31·0	6 21 47·85

Coincidence received from Belmont.

Time by chronometer Reid	Solitude sidereal time
h. m. s.	h. m. s.
13 0 5·0	7 6 29·28

Chronometer Comparisons at Belmont.

1874, December 21.

'Electric contact' chronometer	(36)
h. m. s.	h. m. s.
7 22 10·0	9 37 57·5
7 25 20·0	9 41 7·0

'Electric contact' chronometer	(36)
h. m. s.	h. m. s.
8 44 50·0	11 0 24·0
8 47 49·0	11 3 22·5*

1874, December 23.

'Electric contact' chronometer	(36)
h. m. s.	h. m. s.
2 10 12·0	4 19 5·0
2 13 18·0	4 22 10·5

'Electric contact chronometer	(36)
h. m. s.	h. m. s.
3 24 30·0	5 33 11·0
3 30 20·0	5 39 0·0

* 22''·0 in original.

From the series of time determinations made at Belmont with the reversing transit instrument, details of which will be given in Vol. IV. of the Dun Echt publications, we extract the following particulars :—

Observer, Dr. Copeland. Chronometer 'Electric Contact' with Chronograph.

Date, 1874	Time by 'electric contact' chronometer		Correction of 'electric contact' chronometer to local sidereal time		Hourly rate
	h. m.	h. m.	s.	s.	s.
Dec. 21 1st group .	2 3	4 30	−52·270	52·145	+0·051
„ 21 1st group .	6 57		52·020		+0·0458
„ 22 . . .	3 26		51·095		+0·0440
„ 23 . . .	2 27		50·082		

Combining these corrections with the preceding comparisons, we obtain as corrections of chronometer 36 to local mean time :—

Date, 1874	Time by (36)	Correction of (36)	Hourly rate
	h. m.	h. m. s.	s.
Dec. 21	9 39·5	+3 42 14·04	+0·022
„ 21	11 1·9	14·07	
„ 23	4 20·6	+3 42 9·73	−0·079
„ 23	5 36·1	9·63	

And, with these corrections of chronometer 36, we get the following corrections of the chronometers before and after transport to Solitude, as well as their rates during the interval :—

CORRECTIONS OF CHRONOMETERS TRANSPORTED TO AND FROM SOLITUDE.

Rotation No.	1874, DECEMBER 21			1874, DECEMBER 23			Daily rate during the interval
	Time by (36)	Seconds of compared chronometer	Correction of compared chronometer	Time by (36)	Seconds of compared chronometer	Correction of compared chronometer	
	h m. s.	s.	s.	h. m. s.	s.	s.	s.
1	10 6 0	2·3	+11·75	4 34 0	58·6	+11·11	−0·362
2	„	57·4	16·65	„	59·55	10·16	−3·668
3	„	12·0	2·05	„	15·95	53·76	−4·685
4	„	48·5	25·55	„	47·05	22·66	−1·633
7	„	34·6	39·45	„	37·95	31·76	−4·346
8	„	14·5	59·55	„	13·2	56·51	−1·718
9	„	23·6	50·45	„	24·6	45·11	−3·018
10	„	41·4	32·65	„	42·6	27·11	−3·131
11	„	40·3	33·75	„	47·55*	22·16	−6·550
12	10 40 0	7·45	6·61	5 18 0	0·35	9·30	+1·514
13	„	30·6	43·46	„	26·9	42·75	−0·400
14	„	57·0	17·06	„	50·4	19·25	+1·233
15	„	11·0	3·06	„	7·5	2·15	−0·512
16	„	26·15	47·91	„	24·8	44·85	−1·723
17	„	43·0	31·06	„	45·5	24·15	−3·890
18	„	54·5	19·56	„	51·85	17·80	−0·991
19	„	7·4	6·66	„	2·0	7·65	+0·557
20	„	48·0	26·06	„	55·5	14·15	−6·705
21	10 31 0	4·35	9·71	5 9 0	4·2	5·47	−2·387
22	„	23·8	50·26	„	16·3	53·37	+1·751
23	„	54·3	19·76	„	52·5	17·17	−1·458
24	„	42·55	31·51	„	41·0	28·67	−1·599
25	„	28·3	45·76	„	31·55	38·12	−4·301
26	„	15·0	59·06	„	7·5	2·17	+1·751
27	„	19·75	54·31	„	9·0	0·67	+3·580
28	„	20·8	53·26	„	15·4	54·27	+0·569
29	„	36·0	38·06	„	29·1	40·57	+1·413
30	10 23 0	56·2	17·86	4 52 0	6·0	3·69	−8·005
32	„	53·3	20·76	„	48·55	21·14	+0·215
33	„	6·8	7·26	„	4·55	5·14	−1·198
34	„	5·55	8·51	4 53 0	0·55	9·14	+0·356
35	„	21·85	52·21	„	18·2	51·49	−0·407
37	„	9·7	4·36	„	8·3	1·39	−1·677
42	10 45 0	11·6	2·46	5 5 0	7·1	2·57	+0·062
50	10 23 0	38·5	35·56	4 56 0	35·4	34·28	−0·722

* 37ˢ·55 in original.

Operations at Belmont.

By interpolation we obtain the corrections of the chronometers to Belmont mean time at the times of their comparison at Solitude, and bringing over the corresponding corrections to Solitude time, arrived at on p. 117, the difference of longitude by each chronometer comes out as in the annexed table :—

Rotation No.	1874, December 22					
	Belmont to Solitude			Solitude to Belmont		
	Chronometer correction on Belmont mean time	Chronometer correction on Solitude mean time	Resulting longitude, Solitude west of Belmont	Chronometer correction on Belmont mean time	Chronometer correction on Solitude mean time	Resulting longitude, Solitude west of Belmont
	s.	s.	h. m. s.	s.	s.	h. m. s.
1	+11·45	+10·11	0 0 1·34	+11·28	+10·30	0 0 0·98
2	13·60	12·71	0·89	11·92	11·10	0·82
3	58·15	57·16	0·99	56·01	55·20	0·81
4	24·19	23·21	0·98	23·44	22·75	0·69
7	35·83	34·91	0·92	33·85	33·20	0·65
8	58·12	56·86	1·26	57·34	56·25	1·09
9	47·94	46·91	1·03	46·56	45·65	0·91
10	30·04	29·11	0·93	28·61	27·90	0·71
11	28·30	27·11	1·19	25·31	24·35	0·96
12	7·89	6·83	1·06	8·51	7·39	1·12
13	43·12	42·38	0·74	42·96	42·69	0·27
14	18·10	16·88	1·22	18·61	17·64	0·97
15	2·63	1·98	0·65	2·42	1·64	0·78
16	46·46	45·88	0·58	45·75	45·34	0·41
17	27·78	26·83	0·95	26·18	25·19	0·99
18	18·73	17·93	0·80	18·32	17·64	0·68
19	7·13	6·33	0·80	7·36	6·69	0·67
20	20·41	19·33	1·08	17·64	16·64	1·00
21	7·67	6·66	1·01	6·65	5·65	1·00
22	51·76	50·86	0·90	52·50	51·65	0·85
23	18·51	17·81	0·70	17·89	17·30	0·59
24	30·14	29·26	0·88	29·46	28·65	0·81
25	42·08	41·11	0·97	40·25	39·45	0·80
26	0·56	59·76	0·80	1·30	0·65	0·65
27	57·37	56·31	1·06	58·90	57·75	1·15
28	53·75	52·81	0·94	53·99	53·35	0·64
29	39·27	38·31	0·96	39·87	39·25	0·62
30	11·17	10·17	1·00	7·82	7·24	0·58
32	20·94	19·72	1·22	21·03	20·19	0·84
33	6·26	5·32	0·94	5·76	5·34	0·42
34	8·81	7·87	0·94	8·96	8·19	0·77
35	51·87	50·82	1·05	51·70	50·64	1·06
36	11·99	11·17	0·82	10·91	10·14	0·77
37	2·96	3·97*	...	2·26	1·64	0·62
42	2·51	1·32	1·19	2·54	1·69	0·85
50	34·96	34·07	0·89	34·65	33·79	0·86

* Signal probably 2ˢ wrong (rejected).

Finally, taking the mean, we get :—

	h.	m.	s.	s.
Solitude west of Belmont	0	0	0·88	±0·02

Signals sent to and received from Solitude.

Below are tabulated the chronometer and local sidereal times of despatch and receipt of signals at Belmont, and with them, brought over from p. 118, the corresponding Solitude times of sending and receiving the same signals at that end of the line. The last column contains the deduced longitude. Appended are the results of the coincident signals :—

1874, DECEMBER 22

	SET 1						SET 2			
No. of signal	Time by 'electric contact' chronometer	Belmont sidereal time, signals received	Corresponding Solitude sidereal time, signals sent	Resulting longitude, Solitude west of Belmont	Time by 'electric contact' chronometer	Belmont sidereal time, signals sent	Corresponding Solitude sidereal time, signals received	Resulting longitude, Solitude west of Belmont
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	6 18 18·0	6 17 27·03	6 17 26·12	0 0 0·91	7 4 40·0	7 3 49·07	7 3 48·03	0 0 1·04
2	28·0	37·03	36·15	0·88	50·0	59·07	57·96	1·11
3	38·0	47·03	46·18	0·85	5 10·0	4 19·07	4 18·01	1·06
4	48·0	57·03	56·21	0·82	20·0	29·07	28·14	0·93
5	58·0	18 7·03	18 6·23	0·80	30·0	39·07	38·06	1·01
6	19 8·0	17·03	16·26	0·77	40·0	49·07	48·19	0·88
7	18·0	27·03	26·29	0·74	7 5 50·0	7 4 59·07	7 4 58·22	0·85
8	28·0	37·03	36·31	0·72				
9	38·2	47·23	46·34	0·89				
10	48·0	57·03	56·37	0·66				
11	58·0	19 7·03	19 6·40	0·63				
12	6 20 8·1	6 19 17·13	6 19 16·42	0·71				
TELEGRAPHED COINCIDENCES OF CHRONOMETERS								
...	6 22 40·0	6 21 49·03	6 21 47·85	0 0 1·18	7 7 21·0	7 6 30·07	7 6 29·28	0 0 0·79

The mean values are :—

	h.	m.	s.
By signals sent from Solitude; Solitude west of Belmont	0	0	0·782
„ „ Belmont „ „			0·983
By coincidence sent from Solitude „ „			1·18
„ „ Belmont „ „			0·79

Or grouping the results by the different methods :—

	h.	m.	s.
Solitude west of Belmont by telegraphic signals	0	0	0·88
„ „ „ coincidences	[		0·98]
„ „ chronometers (see p. 120)			0·88

Considering the coincidences merely as a check, we have:—

	h.	m.	s.
Solitude west of Belmont	0	0	0·88
Personal equation between Drs. Pechüle and Copeland in determining the time*			+0·08
Difference between chronograph beat and beat of 'electric contact' chronometer †			−0·07

Therefore, finally :—

	h.	m.	s.
Solitude west of Belmont	0	0	0·89

* See Chapter VIII.

† *Ibid.* The escapement beat occurs 0ˢ·07 earlier than the chronograph beat. The observations were taken at Belmont by the transit chronograph, but the signals were transmitted in accordance with the escapement beat.

CHAPTER V.

DETERMINATION OF THE DIFFERENCE OF PERSONAL EQUATION IN FINDING THE TIME BETWEEN LIEUTENANT NEATE, MR. BURTON, AND MR. GILL.

To find the personal equation between Lieutenant Neate, Mr. Burton, and Mr. Gill, in observing transits of stars, Messrs. Neate and Burton observed with their own transit instrument, erected in the meridian of the reversing transit instrument at Belmont, noting the time by their sidereal clock exactly as in their observations at Rodriguez. Mr. Gill used the Troughton and Simms' altazimuth in a detached observatory 46·5 feet to the west, taking the time from a sidereal chronometer beating half-seconds. Mr. Gill did not use the method of transits in the vertical of a pole star as practised in the longitude operations, but preferred using the altazimuth as a transit instrument; owing, however, to peculiarities in the instrument, it could not be conveniently reversed in its Y's for night work, hence the instrument was reversed by turning it 180° in azimuth and setting it by the horizontal circle. In this way each time determination involves one value of correction for collimation and two for azimuth. The reductions were readily made by successive approximations, the more so as the collimation error was fairly constant. The sidereal timekeepers were compared by the aid of a mean-time chronometer to obtain the advantage of coincident beats. Mr. Gill's observations being thus referred to the sidereal clock, gave the desired personal equations.

Operations at Belmont.

Observations for Personal Equation between Lieutenant Neate, Mr. Burton, and Mr. Gill.

Comparisons of Clock and Chronometers.

1874, December 25.

(43)	(31)	(43)	(31)
h. m. s.	h. m. s.	h. m. s.	h. m. s.
6 54 43·5	8 47 40·0	7 34 7·0	9 26 57·0

(31)	Transit clock	Observer
h. m. s.	h. m. s.	
8 58 49·5	7 4 20·0	Mr. Gill
9 7 45·0	7 13 16·0*	Lieutenant Neate
9 15 26·5	7 20 58·0	Mr. Burton
9 22 29·0	7 28 1·0†	Mr. Gill

December 26.

(43)	(31)	(31)	Transit clock
h. m. s.	h. m. s.	h. m. s.	h. m. s.
3 7 56·0	4 57 35·0	5 9 25·5	3 20 43·0
3 10 57·5	5 0 36·0	5 12 50·0	3 24 8·0

December 27.

(43)	(31)	(43)	(31)	(31)	Transit clock
h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
4 27 24·0	6 12 56·0	4 58 3·0	6 43 30·0	6 25 45·5	4 40 56·0
		5 1 6·5	6 46 33·0	6 32 15·5	4 47 27·0‡

* 15ˢ·0 in original. † 0ˢ·0 in original. ‡ 26ˢ·0 in original.

OBSERVATIONS TAKEN WITH THE RODRIGUEZ TRANSIT INSTRUMENT AND TRANSIT CLOCK.
OBSERVERS, LIEUTENANT NEATE (N) AND MR. BURTON (B).

Date, 1874	Observer	Name of star	Position of micrometer	Reading of telescope micrometer	Seconds of transit over the wires I.	II.	III.	IV.	V.	Concluded clock time of transit over wire III.	Level readings E	W
				r.	s.	s.	s.	s.	s.	h. m. s.	p.	p.
Dec. 25	N	ϵ Orionis	E	20·341	47·0	32·7	18·1	4·0	50·1	5 28 18·31	10·6	23·2
		Lacaille 2512*	,,	...	...	...	...	...	...	6 11 20·10	54·3	66·8
		ϵ Canis maj.	,,	20·402	33·0	17·0	0·7	44·1	...	6 52 0·54	10·4	23·2
		δ Geminorum	,,	,,	26·3	10·9	55·5	40·1	25·2	7 10 55·53	54·1	67·4
		α Canis min.	,,	,,	28·0	13·1	59·2	...	30·9	7 30 59·16	...	...
		6 Cancri	,,	20·400	34·7	18·4	2·2	46·1	30·0	7 54 2·21	11·0	22·2
		η Cancri	,,	,,	8·0	53·1	37·7	22·1	7·4	8 23 37·59	54·8	66·9
	B	α Columbæ	E	20·401	7·5	50·4	33·0	...	...	5 33 33·08	...	...
		α Canis maj.	,,	20·400	27·0	12·2	57·7	42·6	28·0	6 37 57·43	9·6	22·0
		α^2 Geminorum	,,	20·402	25·8	9·0	52·2	35·5	18·9	7 24 52·20	54·4	66·8
		15 Argûs	,,	20·400	55·0	39·5	23·5	8·3	53·1	8 0 23·81	As above	

* Lacaille 2512

December 25

Micrometer reading	Clock time	Collimation by collimator E		W	
r.	h. m. s.	r.		r.	r.
19·500	6 10 27·5	20·716	20·718	20·284	20·295
20·000	10 54·0	·714	·712	·288	·291
20·500	11 19·5	·714	·708	·281	·292
21·000	11 46·5	·714	·717	·288	·293
21·500	12 13·0	·712	·708	·291	·291

OBSERVATIONS WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH, USED AS A TRANSIT INSTRUMENT IN TWO POSITIONS OF THE AZIMUTH CIRCLE DIFFERING BY 180°. OBSERVER, MR. GILL; CHRONOMETER 43.

Date, 1874	Name of star	Position of circle	Level readings		Seconds by chronometer of transit over wires I.	II.	III.	IV.	V.	Concluded chronometer time of transit over wire III.	Level readings E	W
					s.	s.	s.	s.	s.	h. m. s.	p.	p.
Dec. 25	Lacaille 1592	E	...	...	...	2·0	5·0	14·0	...	4 8 4·55	20·2	12·0
											21·3	11·0
	ϵ Tauri	,,	...	...	...	...	6·4	53·0	39·0	4 21 6·62	21·3	10·8
											20·0	12·0
	α Tauri	,,	...	...	0·8	47·0	33·0	...	...	4 28 32·92	...	...
	τ Tauri	,,	...	...	0·4	46·3	31·6	17·4	3·2	4 34 31·54	20·2	11·8
											21·8	10·5
	μ Eridani	,,	...	...	33·0	19·5	6·0	53·0	39·8	4 39 6·03	21·3	11·2
											21·2	10·8
	β Orionis	,,	...	...	50·5	37·0	23·4	10·4	57·0	5 8 23·43	21·8	10·5
											20·2	12·0
	α Columbæ	W	...	...	...	44·0	0·4	16·0	32·1	5 35 0·38	16·2	16·2
											20·5	11·8
	α Orionis	,,	...	...	45·0	58·1	...	...	...	5 48 11·89	...	...
	Lacaille 2512	,,	...	...	56·0	3·0	14·0	16·0	...	6 14 13·38	19·2	14·0
											19·0	14·0
	γ Geminorum	,,	...	...	47·6	1·5	15·6	...	...	6 30 15·59	17·5	15·4
											19·2	13·8
	α Canis maj.	,,	...	...	0·5	14·4	28·4	42·2*	56·0	6 39 28·54	18·0	15·0
											20·1	13·0

* 32·2 in original.

OBSERVATIONS WITH THE RODRIGUEZ TRANSIT INSTRUMENT AND TRANSIT CLOCK.
OBSERVERS, LIEUTENANT NEATE AND MR. BURTON.

Date, 1874	Observer	Name of star	Position of micrometer	Reading of telescope micrometer	Seconds by clock of transit over wires I.	II.	III.	IV.	V.	Concluded clock time of transit over wire III.	Level readings E	W
				r.	s.	s.	s.	s.	s.	h. m. s.	p.	p.
Dec. 26	N	*a* Persei	E	20·500	53·6	31·2	9·7	47·8	26·0	3 16 9·56	...	...
		o^2 Eridani	,,	,,	43·1	28·2	14·0	59·8	45·4	4 10 14·03	...	...
		ϵ Tauri	,,	,,	32·9	17·6	2·7	47·7	32·6	4 22 2·63	11·1	26·1
											52·1	67·2
		a Tauri	,,	,,	58·2	43·0	28·0	13·0	58·7	4 29 28·11	...	...
		ι Aurigæ	,,	20·420	8·9	51·7	34·6	17·7	0·8	4 49 34·66	...	...
		64 Eridani	,,	20·500	19·1	4·1	50·0	35·2	20·6	4 54 49·73	10·9	25·3
											52·7	66·7
	B	*z* Octantis S.P.*	E	20·500	...	...	...	...	...	2 29 55·09	11·5	27·6
											51·6	68·0
		δ Arietis	,,	,,	43·2	28·2	12·7	57·7	43·0	3 5 12·89		
		o^1 Eridani	,,	,,	57·6	43·0	28·6	14·3	0·1	4 6 28·65		
		54 Persei	,,	,,	36·4	18·6	1·5	44·4	27·3	4 13 1·56	As above	
		i Tauri	,,	,,	16·5	1·5	46·6	31·4	16·5	4 44 46·43		
		ϵ Leporis	,,	,,	23·1	7·5	52·2	36·6	21·5	5 0 52·11		

* *z* Octantis S.P.

Micrometer reading	Clock time	Micrometer reading	Clock time
r.	h. m. s.	r.	h. m. s.
23·000	2 26 11·0	20·000	2 30 39·0
22·500	26 55·0	19·500	31 26·0
22·000	27 38·0	19·000	32 9·0
21·500	28 25·5	18·500	32 56·0
21·000	29 8·5	18·000	33 42·0
20·500	29 56·0		

December 26

Collimation by collimator			
E		W	
r.	r.	r.	r.
20·956	20·961	20·006	20·017
·962	·962	·014	·018
·957	·966	·014	·016
·967	·961	·020	·019
·960	·963	·005	·021
...	...	·009	...

OBSERVATIONS WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH.
OBSERVER, MR. GILL; CHRONOMETER 43.

Date, 1874	Name of star	Position of circle	Level readings		Seconds by chronometer of transit over wires I.	II.	III.	IV.	V.	Concluded chronometer time of transit over wire III.	Level readings E	W
					s.	s.	s.	s.	s.	h. m. s.	p.	p.
Dec. 26	Lacaille 764	W	...	...	...	48·5	36·0	20·0	...	2 6 37·14	18·9	13·5
											16·1	15·9
	69 Ceti	,,	...	...	49·8	3·0	16·4	29·3	...	2 15 16·46	15·8	16·0
											18·5	13·4
	ξ^2 Ceti	,,	...	...	46·8	0·3	14·0	27·1	40·4	2 21 13·95	18·2	13·5
											16·9	15·0
	z Octantis S.P.	E	...	...	...	...	...	26·0	44·0	2 25 11·00	19·7	12·3
											20·0	12·0
	Lacaille 1029	,,	...	...	33·0	8·0	42·5	...	...	2 41 40·89	20·0	12·2
											20·0	12·0
	6 Eridani	,,	...	...	51·8	37·0	22·1	...	...	2 52 22·23	...	...
	a Ceti	,,	...	...	58·0	44·4	31·0	17·8	4·4	2 55 30·89	20·2	11·8
											20·8	11·5

OBSERVATIONS WITH THE RODRIGUEZ TRANSIT INSTRUMENT AND TRANSIT CLOCK.
OBSERVERS, LIEUTENANT NEATE AND MR. BURTON.

Date, 1874	Observer	Name of star	Position of micrometer	Reading of telescope micrometer	Seconds by clock of transit over wires I.	II.	III.	IV.	V.	Concluded clock time of transit over wire III.	Level readings E	W
				r.	s.	s.	s.	s.	s.	h. m. s.	p.	p.
Dec. 27	N	$\varkappa$ Octantis S.P.*	E	20·500	...	...	...	...	...	2 30 20·20	25·0	12·6
											66·0	52·1
		σ Arietis	,,	,,	31·4	16·7	2·0	47·2	32·5	2 45 1·89	...	...
		ϵ Eridani	,,	,,	56·8	41·9	27·4	13·0	58·9	3 27 27·53	26·0	11·4
											66·9	52·4
		η Tauri	,,	,,	1·1	45·9	29·9	14·8	59·1	3 40 30·09	...	...
		A^1 Tauri	,,	,,	15·6	0·0	44·9	29·5	...	3 57 44·79	At $5^h\ 5^m$	
		Lacaille 1592†	,,	,,	...	...	...	...	...	4 6 3·90	27·5	8·9
											68·9	50·3
		β Tauri	,,	20·490	22·0	5·8	49·6	33·1	17·1	5 18 49·45	...	...
	B	6 Eridani	E	20·500	27·7	11·9	56·6	41·0	25·5	2 52 56·47	As above	
		o Tauri	,,	,,	59·8	45·4	31·0	16·5	...	3 18 30·94		
		10 Tauri	,,	,,	23·5	9·0	54·8	40·8	26·5	3 30 54·85		
		γ^1 Eridani	,,	20·497	5·6	50·6	36·1	21·5	6·8	3 52 36·05		
		ϵ Leporis	,,	20·490	4·2	48·6	33·1	17·7	2·5	5 0 33·15		
		δ Orionis	,,	20·489	29·4	15·2	1·0	46·7	32·8	5 26 0·95		

* $\varkappa$ Octantis S.P.

Micrometer reading	Clock time
r.	h. m. s.
21·000	2 29 34·5
20·750	29 57·0
20·500	30 19·5
20·250	30 41·5
20·000	31 8·5

† Lacaille 1592

Micrometer reading	Clock time
r.	h. m. s.
19·500	4 5 15·5
20·000	5 39·5
20·500	6 4·5
21·000	6 28·0
21·500	6 52·0

December 27

Collimation by collimator

E		W	
r.	r.	r.	r.
21·296	21·303	19·667	19·678
·302	·297	·674	·663
·298	·310	·680	·662
·300	·301	·675	·674
·306	·305	·662	·676

OBSERVATIONS WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH. OBSERVER, MR. GILL; CHRONOMETER 43.

Date, 1874	Name of star	Position of circle	Level readings		Seconds by chronometer of transit over wires I.	II.	III.	IV.	V.	Concluded chronometer time of transit over wire III.	Level readings E	W
					s.	s.	s.	s.	s.	h. m. s.	p.	p.
Dec. 27	$\varkappa$ Octantis S.P.	E	...	...	...	47·0	6·5	22·0	...	2 25 9·68	19·2	12·6
											20·2	11·6
	Lacaille 1029	,,	...	...	...	6·5	...	16·0	54·0	2 41 37·00	20·5	11·5
											20·0	12·3
	6 Eridani	,,	...	...	48·0	33·3	18·0	4·0	...	2 52 18·34	...	...
	a Ceti	,,	...	...	53·7	...	27·0	14·0	0·5	2 55 26·92	19·5	12·2
											20·5	11·3
	o Tauri	,,	...	...	13·8	0·3	46·9	33·6	20·4	3 17 46·77	20·0	11·6
											21·0	10·8
	10 Tauri	,,	...	...	39·1	26·0	12·4	59·5	46·3	3 30 12·43	20·5	11·4
											20·8	10·8
	η Tauri	W	...	...	11·2	25·5	40·4	54·7	9·1	3 39 40·43	17·1	14·3
											16·5	15·0
	A^1 Tauri	,,	...	...	27·0	41·2	55·9	9·9	24·0	3 56 55·84	18·3*	13·3
											16·2	15·8
	ω^1 Tauri	,,	...	...	2·6	16·4	31·0	44·8	58·7	4 1 30·94	...	...
	Lacaille 1592	,,	...	...	...	17·5	16·0	8·0	...	4 7 16·28	18·3	13·3
											17·4	14·6
	θ^1 Tauri	,,	...	...	36·6	50·7	4·5	18·0	31·8	4 21 4·56	19·1	12·6
											17·4	14·2

* Readings reversed in original, E for W.

The reductions call for little comment beyond what has already been said. On December 25 the rate of the Rodriguez clock was unusually large and had therefore to be strictly allowed for in the reductions of the pole star. As the transits of the pole stars were taken by only one of the Rodriguez observers, it was assumed that there is no appreciable personal equation for these slow-moving stars, the transits of which were accordingly used for separately finding the azimuth for each observer.

a. Rodriguez Transit Instrument and Transit Clock.

Provisional clock rate + 5ˢ·95 per hour.

Level	Micrometer reading when collimation is zero	Azimuth N	Azimuth B
s.	r.	s.	s.
−0·637	20·5013	+0·619	+0·611

Date, 1874	Epoch by clock	Observer	Name of star	Position of micrometer	Concluded clock time of transit over wire III.	Sum of instrumental corrections	R.A. of star, including daily aberration	Clock correction
	h. m. s.				h. m. s.	s.	h. m. s.	m. s.
Dec. 25	7 13 19	N	ε Orionis	E	5 28 18·31	−0·20	5 29 53·14	+1 35·03
			ε Canis maj.	„	6 52 0·54	−0·19	6 53 43·93	43·58
			δ Geminorum	„	7 10 55·53	−0·56	7 12 40·40	45·43
			α Canis min.	„	7 30 59·16	−0·47	7 32 46·27	47·58
			6 Cancri	„	7 54 2·21	−0·57	7 55 51·34	49·70
			η Cancri	„	8 23 37·59	−0·54	8 25 29·55	52·50
	6 54 11	B	α Columbæ	E	5 33 33·08	−0·12	5 35 8·84	+1 35·88
			α Canis maj.	„	6 37 57·43	−0·30	6 39 39·31	42·18
			α^2 Geminorum	„	7 24 52·20	−0·59	7 26 38·45	46·84
			15 Argûs	„	8 0 23·81	−0·24	8 2 14·08	50·51

b. Troughton and Simms' Altazimuth.

Provisional chronometer rate + 0ˢ·165 per hour.

	Level	Collimation	Azimuth
	s.	s.	s.
Circle E	−1·093	−0·910	−8·284
„ W	−0·476	+0·910	−6·957

Observer, Mr. Gill; Chronometer 43.

Date, 1874	Epoch by chronometer	Name of star	Position of circle	Concluded chronometer time of transit over wire III.	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m.			h. m. s.	s.	h. m. s.	s.
Dec. 25	5 23·2	ε Tauri	E	4 21 6·62	+3·64	4 21 19·80	+9·54
		α Tauri	„	4 28 32·92	+3·24	4 28 45·67	9·51
		τ Tauri	„	4 34 31·54	+4·23	4 34 45·36	9·59
		μ Eridani	„	4 39 6·03	+0·40	4 39 16·01	9·58
		β Orionis	„	5 8 23·43	−0·30	5 8 32·77	9·64
		α Columbæ	W	5 35 0·38	−1·51	5 35 8·84	9·97
		α Orionis	„	5 48 11·89	+3·73	5 48 25·18	9·56
		γ Geminorum	„	6 30 15·59	+4·87	6 30 30·34	9·88
		α Canis maj.	„	6 39 28·54	+0·90	6 39 39·31	9·87

a. Rodriguez Transit Instrument aud Transit Clock.

Provisional clock rate +0ˢ·820 per hour.

Level	Micrometer reading when collimation is zero	Azimuth N	Azimuth B
s.	r.	s.	s.
−0·778	20·4880	+1·674	+1·689

Date, 1874	Epoch by clock	Observer	Name of star	Position of micrometer	Concluded clock time of transit over wire III.	Sum of instrumental corrections	R.A. of star, including daily aberration	Clock correction
	h. m.				h. m. s.	s.	h. m. s.	s.
Dec. 26	4 20·4	N	*a* Persei	E	3 16 9·56	−2·90	3 15 24·82	−41·84
			o^2 Eridani	„	4 10 14·03	−1·18	4 9 31·95	40·90
			ϵ Tauri	„	4 22 2·63	−1·80	4 21 19·81	41·02
			a Tauri	„	4 29 28·11	−1·73	4 28 45·67	40·71
			ι Aurigæ	„	4 49 34·66	−1·85	4 48 52·16	40·65
			64 Eridani	„	4 54 49·73	−1·06	4 54 8·18	40·49
	4 14·1	B	δ Arietis	E	3 5 12·89	−1·82	3 4 29·37	−41·70
			o^1 Eridani	„	4 6 28·65	−1·19	4 5 46·61	40·85
			54 Persei	„	4 13 1·56	−2·26	4 12 18·56	40·74
			i Tauri	„	4 44 46·43	−1·80	4 44 4·59	40·04
			ϵ Leporis	„	5 0 52·11	−0·81	5 0 11·29	40·01

b. Troughton and Simms' Altazimuth.

Provisional chronometer rate +0ˢ·163 per hour.

	Level	Collimation	Azimuth
		s.	s.
Circle W	As determined for	+0·923	−7·115
„ E	each star	−0·923	−7·255

OBSERVER, MR. GILL; CHRONOMETER 43.

Date, 1874	Epoch by chronometer	Name of star	Position of circle	Concluded chronometer time of transit over wire III.	Sum of instrumental corrections	R.A of star, including daily aberration	Chronometer correction
	h. m.			h. m. s.	s.	h. m. s.	s
Dec. 26	2 36·1	69 Ceti	W	2 15 16·46	+3·10	2 15 32·66	+13·10
		ξ^2 Ceti	„	2 21 13·95	+3·99	2 21 31·06	13·12
		6 Eridani	E	2 52 22·23	−2·57	2 52 32·92	13·26
		a Ceti	„	2 55 30·89	+1·15	2 55 45·18	13·14

a. Rodriguez Transit Instrument and Transit Clock.

Provisional clock rate +0ˢ·880 per hour.

Level	Micrometer reading when collimation is zero	Azimuth N	Azimuth B
	r.	s.	s.
Interpolated	20·4864	+2·935	+2·935

Date, 1874	Epoch by clock	Observer	Name of star	Position of micrometer	Concluded clock time of transit over wire III.	Sum of instrumental corrections	R.A. of star, including daily aberration	Clock correction
	h. m.				h. m. s.	s.	h. m. s.	s.
Dec. 27	3 49·9	N	σ Arietis	E	2 45 1·89	−1·18	2 44 35·83	−24·88
			ϵ Eridani	„	3 27 27·53	+0·19	3 27 3·17	24·55
			η Tauri	„	3 40 30·09	−1·66	3 40 3·89	24·54
			A¹ Tauri	„	3 57 44·79	−1·51	3 57 19·03	24·25
			β Tauri	„	5 18 49·45	−1·79	5 18 24·39	23·27
	4 0·3	B	6 Eridani	E	2 52 56·47	+0·94	2 52 32·92	−24·49
			o Tauri	„	3 18 30·94	−0·81	3 18 5·79	24·34
			10 Tauri	„	3 30 54·85	−0·34	3 30 30·30	24·21
			γ^1 Eridani	„	3 52 36·05	+0·47	3 52 12·64	23·88
			ϵ Leporis	„	5 0 33·15	+1·15	5 0 11·29	23·01
			δ Orionis	„	5 26 0·95	−0·10	5 25 38·16	22·69

b. Troughton and Simms' Altazimuth.

Provisional chronometer rate +0ˢ·163 per hour.

	Level	Collimation	Azimuth
		s.	s.
Circle E . . .	Interpolated	−0·894	−7·234
„ W . . .	„	+0·894	−7·226

Observer, Mr. Gill; Chronometer 43.

Date, 1874	Epoch by chronometer	Name of star	Position of circle	Concluded chronometer time of transit over wire III.	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m.			h. m. s.	s.	h. m. s.	s.
Dec. 27	3 34·4	6 Eridani	E	2 52 18·34	−2·49	2 52 32·92	+17·07
		a Ceti	„	2 55 26·92	+1·22	2 55 45·17	17·03
		o Tauri	„	3 17 46·77	+1·75	3 18 5·79	17·27
		10 Tauri	„	3 30 12·43	+0·65	3 30 30·30	17·22
		η Tauri	W	3 39 40·43	+6·26	3 40 3·89	17·20
		A¹ Tauri	„	3 56 55·84	+5·90	3 57 19·03	17·29
		ω^1 Tauri	„	4 1 30·94	+5·52	4 1 53·76	17·30
		θ^1 Tauri	„	4 21 4·56	+4·89	4 21 26·80	17·35

The means of the clock corrections for the separate groups were then taken, and in the case of the Rodriguez clock hourly rates were derived by combining the stars within each group, while for chronometer 43 a uniform rate was adopted. The collected results are :—

Date			Correction to local sidereal time			Adopted hourly rate
			s.	m.	s.	s.
1874, Dec. 25 .	Lieut. Neate at 7 h. 13 m. 19	by transit clock	...	...	+1 45·637	+5·988
„ „ .	Mr. Burton „ 6 54 11	„	...	...	+1 43·852	„
„ „ .	Mr. Gill „ 5 23 12	by chronometer 43	...	...	+0 9·70	+0·163
„ Dec. 26 .	Lieut. Neate „ 4 h. 20·4 m.	by transit clock	...	...	− 40·935	+0·864
„ „ .	Mr. Burton „ 4 14·1	„	...	...	− 40·668	„
„ „ .	Mr. Gill „ 2 36·1	by chronometer 43	...	...	+ 13·155	+0·163
„ Dec. 27 .	Lieut. Neate „ 3 49·9	by transit clock	...	...	− 24·298	+0·701
„ „ .	Mr. Burton „ 4 0·3	„	...	...	− 23·770	„
„ „ .	Mr. Gill „ 3 34·4	by chronometer 43	...	...	+ 17·22	+0·163

Then, using Mr. Gill's corrections and the comparisons of chronometer 43 with the mean-time chronometer 31, and of chronometer 31 again with the transit clock, we find the correction of the transit clock as determined by Mr. Gill :—

1874, Dec. 25 at 7 h. 16 m. 39	by transit clock	correction to local sidereal time	+1 m. 46·148 s.
„ „ 26 „ 3 h. 22·4 m.	„	„	−0 41·255
„ „ 27 „ 4 44·2	„	„	−0 22·965

Next, reducing all the corrections to one epoch (that of Lieutenant Neate), we have :—

Corrections to Local Sidereal Time.

Date	Lieut. Neate	Mr. Burton	Mr. Gill
	m. s.	m. s.	m. s.
1874, Dec. 25	+1 45·637	+1 45·761	+1 45·815
„ „ 26	− 40·935	− 40·577	− 40·420
„ „ 27	− 24·298	− 23·892	− 23·600

Or,

	Lieutenant Neate−Mr. Burton	Lieutenant Neate−Mr. Gill
	s.	s.
1874, Dec. 25	−0·124	−0·178
„ „ 26	−0·358	−0·515
„ „ 27	−0·406	−0·698

Finally, taking the means and applying $+0^s\cdot033$ to Mr. Gill's corrections, for the difference of longitude between the transit instrument and the altazimuth, we find the equations to reduce the clock corrections to Lieutenant Neate as standard :—

$$\text{Neate}-\text{Burton} = -0^s\cdot30$$
$$\text{Neate}-\text{Gill} = -0\cdot50 \pm 0^s\cdot103$$

CHAPTER VI.

BELMONT-PAMPLEMOUSSES LONGITUDE.

THE observations for time on arrival at Mauritius having been made at the Royal Alfred Observatory, Pamplemousses, and this observatory having also been made the point of departure in the longitude operations between Rodriguez and Mauritius, it became necessary to determine the difference of longitude between Pamplemousses and Lord Lindsay's station at Belmont. At the time arranged for doing this, Lord Lindsay and Dr. Copeland being both prostrated by fever, Dr. Pechüle most kindly volunteered to do the work at Belmont. Accordingly, on January 2, 1875, Mr. Gill again set up the Troughton and Simms' altazimuth in the same position as that occupied at Pamplemousses in the former determinations; chronometers 31, 38, 39, 40, and 43 were compared at Belmont and transported to Pamplemousses. On their return they served to give a closely approximate value for the longitude. As a further check on the longitude results, a number of rockets were sent up from Belmont, commencing at $11^h\ 30^m$ P.M. on January 2. The instant of bursting was not so well marked as might have been wished, the rockets having been made to burn for a short time rather than to burst with a single bright flash. Mr. Gill attempted to estimate the first change from orange to white (magnesium) light.

On January 2 no electric signals could be exchanged, from the fact, afterwards discovered, that the Belmont signals had been inadvertently switched to Mahébourg instead of to Pamplemousses. Next morning Mr. Watt, the Superintendent of Telegraphs, most obligingly came to Pamplemousses and personally examined all the electrical connections, &c. Some further difficulties having arisen, Mr. Watt drove over to Belmont and so arranged that signals were satisfactorily exchanged about 2 P.M. on January 3. The remaining signals were sent during the night, and the chronometers were returned to Belmont the day after.

Dr. Pechüle observed at Belmont with Dr. Löw's transit instrument in the meridian of the reversing transit instrument.

CHRONOMETER COMPARISONS AT PAMPLEMOUSSES.

1875, JANUARY 2.

	h.	m.	s.		h.	m.	s.		h.	m.	s.		h.	m.	s.		h.	m.	s.
(43)	8	13	55·0	(38)	9	58	24·5	(43)	17	37	43·0	(38)	19	20	43·0	(43)	22	37	12·0	(38)	0	19	24·5
(43)	8	17	53·0	(39)	10	14	25·0	(43)	17	31	5·0	(39)	19	26	12·0	(43)	22	27	3·0	(39)	0	21	24·5
(43)	8	19	30·0	(40)	9	53	34·5	(43)	17	33	38·5	(40)	19	6	15·0	(43)	22	33	0·0	(40)	0	4	49·0
(43)	8	23	24·0	(31)	9	44	52·0	(43)	17	29	13·0	(31)	18	49	12·0	(43)	22	14	56·0	(31)	23	34	8·5

1875, JANUARY 3.

	h.	m.	s.		h.	m.	s.
(43)	5	9	12·0	(31)	6	27	17·0
(43)	8	26	16·0	(38)	10	6	55·0
(43)	8	16	13·0	(39)	10	9	4·0
(43)	8	21	56·0	(40)	9	52	11·5
(43)	8	19	45·0	(31)	9	37	19·0

Time Determinations at Pamplemousses.

The observations were taken with the Troughton and Simms' altazimuth used as a transit instrument. The instrument was brought as nearly as possible into the meridian, and a sufficient number of observations having been obtained in one position, it was turned 180° in azimuth and a corresponding set was then taken in the other position.

Observer, Mr. Gill; Chronometer 43.

Date, 1875	Name of star	Position of circle	Seconds by chronometer of transit over wires					Concluded chronometer time of transit over wire III.			Level readings	
			I.	II.	III.	IV.	V.				E	W
			s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Jan. 2	σ Octantis S.P.*	E	...	13·0	...	...	...	6	27	12·53	...	...
	σ Octantis S.P.	„	...	...	...	31·0	...	6	29	11·20	17·5 15·5	14·5 16·5
	μ Geminorum*	„	50·6	36·4	21·7	7·7	53·6	6	15	21·76	17·7 15·0	14·2 17·0 †
	C Puppis	„	24·0	5·9	47·6	30·2	12·4	6	59	47·71	17·0 15·8	15·3 16·4
	51 Geminorum	„	36·9	23·1	9·0	55·4	41·5	7	6	8·95	...	...
	π Argûs	„	1·4	45·0	28·0	11·9	55·2	7	12	28·02	14·8 18·0	17·2 14·0
	β Canis min.	„	44·7	31·8	17·8	3·9	51·1	7	20	17·63	13·5 19·1	18·5 13·0
	6 Cancri ‡	W	13·7	28·9	44·0	...	12·0		...		18·5 14·6	13·8 17·5
	15 Argûs	„	29·9	44·6	59·0	13·4	27·6	8	1	59·15	12·9 18·2	19·2 14·3
	ϵ Hydræ	„	...	44·4	58·5	11·0	24·4	8	39	58·12	19·8 13·5	13·0 18·7
	Lacaille 3759	„	29·5	...	...	18·0	35·0	8	43	6·04	13·5 17·7	19·0 14·8
	B Octantis S.P.	„	...	...	0·0	...	2·0	9	12	0·74	18·0 14·3	14·3 18·0
Jan. 3	α Eridani	W	49·5	14·4	39·9	4·2	29·0	1	32	39·82	15·9 13·0	14·7 17·6
	β Arietis	„	1·9	16·0	30·4	44·2	58·3§	1	47	30·40	16·1 13·0	15·0 17·6
	α Arietis	„	25·2	39·4	54·0	8·0	23·0	1	59	54·17	13·1 16·0	18·0 15·3
	$\varkappa$ Octantis S.P.	„	...	18·0	56·0	42·0	...	2	30	54·15	17·2 14·8	13·5 16·1
	β Doradûs	W	3·0	31·5	0·8	29·0	57·9	5	32	0·93	18·8 14·0	13·2 17·5
	γ Mensæ	„	...	...	...	52·5	48·5	5	35	56·94	15·0 17·3	16·8 14·5
	δ Leporis	„	11·4	25·6	40·0	54·0	8·0	5	45	40·04	12·4 18·1	19·3 13·5
	β Aurigæ	„	41·4	0·0	19·0	37·4	56·0	5	50	19·08	...	...
	1 Geminorum	„	53·9	8·1	23·0	37·0	51·3	5	56	22·90	...	...
	θ Leporis	„	46·5	0·1	14·2	27·4	41·4	6	0	14·15	18·7 13·5	13·2 17·9
	α Argûs	E	57·4	35·6	12·7	51·4	30·0	6	20	13·05	19·2 15·7	12·3 15·5
	ϵ Geminorum	„	9·2	54·5	39·9	25·4	11·0	6	36	39·75	...	...
	α Canis maj.	„	55·1	41·1	27·0	13·4	59·7	6	39	27·02	20·0 14·0	12·0 17·9
	θ Canis maj.	„	43·2	29·7	15·6	2·4	49·0	6	48	15·75	13·0 20·0	18·8 12·0

* Instrument shifted apparently in turning from μ Geminorum back to σ Octantis; μ Geminorum and wire II. of σ Octantis have not been used.
† The levels are reversed in original. ‡ Something wrong with this observation. § 3″·3 in original.

Taking $+0^{s}\cdot146$ as a provisional chronometer rate, and using for each star the levellings recorded or interpolating where no readings are given, we find by successive approximations the following corrections :—

Date		Collimation	Azimuth
		s.	s.
1875, Jan. 2	Circle E	−0·994	+13·748
	„ W	+0·994	+ 5·189
1875, Jan. 3	Circle W, 1st group	+0·993	+ 5·289
	„ „ 2nd „	„	+10·899
	„ E	−0·993	+50·668

Date, 1875	Epoch by chronometer	Name of star	Position of circle	Concluded chronometer time of transit over wire III.	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m.			h. m. s.	s.	h. m. s.	s.
Jan. 2	7 45·4	C Puppis	E	6 59 47·71	+ 5·55	7 0 6·58	+13·32
		51 Geminorum	„	7 6 8·95	− 9·61	7 6 12·68	13·34
		π Argûs	„	7 12 28·02	+ 3·62	7 12 45·05	13·41
		β Canis min.	„	7 20 17·63	− 7·70	7 20 23·33	13·40
		15 Argûs	W	8 1 59·15	+ 1·61	8 2 14·26	13·50
		ε Hydræ	„	8 39 58·12	− 1·45	8 40 10·24	13·57
Jan. 3	1 46·7	α Eridani	W	1 32 39·82	+ 8·22	1 33 4·46	+16·42
1st group		β Arietis	„	1 47 30·40	− 2·43	1 47 44·10	16·13
		α Arietis	„	1 59 54·17	− 2·66	2 0 7·69	16·18
Jan. 3	5 53·2	δ Leporis	W	5 45 40·04	+ 1·35	5 45 58·50	+17·11
2nd group		β Aurigæ	„	5 50 19·08	−12·53	5 50 23·03	16·48
		1 Geminorum	„	5 56 22·90	− 7·07	5 56 32·39	16·56
		θ Leporis	„	6 0 14·15	− 0·04	6 0 31·10	16·99
Jan. 3	6 41·2	ε Geminorum	E	6 36 39·75	−41·12	6 36 15·61	+16·98
3rd group		α Canis maj.	„	6 39 27·02	− 4·55	6 39 39·39	16·92
		θ Canis maj.	„	6 48 15·75	− 8·53	6 48 24·04	16·82

Taking the means, we have :—

Date	Epoch by chronometer		Chronometer correction to local sidereal time		Hourly rate
	h. m.		s.	s.	s.
1875, Jan. 2	7 45·4	Circle E	+13·368	+13·45	+0·1516
		„ W	13·535		
1875, Jan. 3	5 15·6	Circle E	+16·514	+16·71	
		„ W	16·907		

Using these corrections and rates, we find from the comparisons with chronometer 43 the following corrections and rates for the four chronometers compared with it near the times of observation :—

Rotation No.	1875, January 2		1875, January 3		Hourly rate
	Epoch by chronometer	Correction of chronometer to local mean time	Epoch by chronometer	Correction of chronometer to local mean time	
	h. m.	h. m. s.	h. m.	h. m. s.	s.
(38)	9 58·4	+3 27 17·87	10 6·9	+3 27 14·13	−0·1549
(39)	10 14·4	+3 15 14·73	10 9·1	+3 15 3·74	−0·4596
(40)	9 53·6	+3 37 41·98	9 52·2	+3 37 38·33	−0·1522
(31)	9 44·9	+3 50 17·85	6 30·4	+3 50 19·89	+0·0983

All five chronometers then serve to define the corrections of (43) at the critical times of comparison with (31) :—

1875, January 2				
By chronometer	Epoch by (43)	Correction of (43) to local sidereal time	Epoch by (43)	Correction of (43) to local sidereal time
	h. m.	s.	h. m.	s.
(38)	17 32·9	+14·93	22 28·4	+15·72
(39)	„	14·93	„	15·66
(40)	„	14·93	„	15·71
(31)	„	14·87	„	15·68
By its own rate	„	14·93	„	15·68

And thence :—

	h. m.		h. m. s.
At	18 49·2	by (31), correction of (31) to local mean time	+3 50 18·79
„	23 35·7	„ „ „	19·22

1875, January 3. Extrapolating the correction of chronometer 31, the comparisons give :—

	h. m.		s.
At	8 19·7	by (43), correction of (43) to local sidereal time by chronometer 31	+17·23
„	„	„ „ its own rate	17·17
		Mean	+17·20

From these final corrections we obtain the Pamplemousses times given in the tables on pp. 134–136.

The following observations of the bursting of rockets were made by Mr. Gill at Pamplemousses ; at Belmont the times were noted by Dr. Pechüle. The resulting longitude will be found amongst the Belmont observations.

Time by chronometer 43	Pamplemousses sidereal time
h. m. s.	h. m. s.
6 23 8·8	6 23 22·04
6 25 24·1	6 25 37·35
6 27 27·7	6 27 40·95
6 31 33·5	6 31 46·76
6 33 48·8	6 34 2·07

Operations at Pamplemousses.

Signals sent to and received from Belmont.

The subjoined tables contain the chronometer and local sidereal times of the signals sent to and received from Belmont. They are placed here with the rest of the Pamplemousses work, but they will not be called into requisition until we have deduced the corresponding times at Belmont.

1875, January 3

Number of signal	Set 1		Set 2		Set 3	
	Time by chronometer 31	Pamplemousses sidereal time of signals *sent* to Belmont	Time by chronometer 31	Pamplemousses sidereal time of signals *received* from Belmont	Time by chronometer 31	Pamplemousses sidereal time of signals *sent* to Belmont
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	23 0 10·0	21 41 7·53	23 5 5·8	21 46 4·14	23 10 9·8	21 51 8·98
2	30·0	27·58	14·8	13·16	19·5	18·70
3	40·0	37·61	24·6	22·99	29·4	28·63
4	50·0	47·64	34·5	32·92	34·4	33·65
5	1 10·0	42 7·69	44·6	43·05	49·9	49·19
6	20·0	17·72	6 5·0	47 3·51	11 9·7	52 9·04
7	30·0	27·75	15·0	13·54	20·0	19·37
8	40·0	37·77	24·5	23·06	29·8	29·20
9	50·0	47·80	34·5	33·09	39·7	39·12
10	2 10·0	43 7·86	44·5	43·12	49·8	49·25
11	20·0	17·88	7 4·4	48 3·07	12 10·0	53 9·51
12	30·0	27·91	14·3	13·00	19·7	19·23
13	40·0	37·94	34·3	33·05	29·4	28·96
14	50·0	47·97	43·2	41·98	39·3	38·89
15	3 10·0	44 8·02	8 4·0	49 2·84	49·7	49·31
16	20·0	18·05	14·0	12·86	13 9·7	54 9·37
17	30·0	28·07	24·0	22·89	19·6	19·30
18	40·0	38·10	34·1	33·02	29·7	29·42
19	23 3 50·0	21 44 48·13	23 8 44·0	21 49 42·94	39·8	39·55
20	... ...	... ...	... ...	... ...	23 13 49·8	21 54 49·58

SIGNALS SENT TO AND RECEIVED FROM BELMONT—*continued.*

1875, JANUARY 3

Number of signal	SET 4			SET 5			SET 6		
	Time by chronometer 31			Pamplemousses sidereal time of signals *received* from Belmont			Time by chronometer 31			Pamplemousses sidereal time of signals *sent* to Belmont			Time by chronometer 31			Pamplemousses sidereal time of signals *received* from Belmont		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	23	15	5·0	21	56	5·00	23	20	20·0	22	1	20·87	23	24	25·5	22	5	27·04
2			18·2			18·23			29·6			30·50			40·3			41·88
3			33·0			33·07			50·0			50·95			49·4			51·01
4			44·0			44·10		21	9·9		2	10·91			59·6		6	1·23
5			56·0			56·14			19·9			20·93		25	8·0			9·66
6		16	6·9		57	7·07			30·0			31·06			15·7			17·38
7			19·2			19·40			40·2			41·29			25·4			27·10
8			32·7			32·94			50·2			51·32			32·8			34·53
9			39·7			39·96		22	9·2		3	10·37			43·7			45·47
10		17	4·5		58	4·82			18·4			19·59			53·6			55·39
11			19·0			19·36			30·0			31·23		26	4·1		7	5·92
12			30·0			30·39			50·2			51·48			12·6			14·44
13			41·0			41·42		23	10·6		4	11·94			23·9			25·78
14			51·7			52·15			30·1			31·49			32·0			33·90
15			58·4			58·87			39·0			40·41			41·8			43·72
16		18	4·5		59	4·99			45·0			46·43			51·3			53·25
17			11·4			11·91	23	23	50·6	22	4	52·05			59·4		8	1·37
18			23·0			23·54	...		...	...		...		27	13·6			15·61
19			36·4			36·98	...		...	...		...			22·0			24·03
20			45·3			45·90	...		...	...		...			31·1			33·16
21	23	18	55·3	21	59	55·93	...		...	...		...			46·0			48·10
22	...		...	...		...	...		...	...		...			53·3			55·42
23	...		...	...		...	...		...	...		...		28	0·0		9	2·14
24	...		...	...		...	...		...	...		...			7·3			9·46
25	...		...	...		...	...		...	...		...			17·0			19·18
26	...		...	...		...	...		...	...		...	23	28	25·0	22	9	27·21

Number of signal	SET 7			SET 8			SET 9		
	Time by chronometer 31			Pamplemousses sidereal time of signals *sent* to Belmont			Time by chronometer 31			Pamplemousses sidereal time of signals *received* from Belmont			Time by chronometer 43			Pamplemousses sidereal time of signals *sent* to Belmont		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	5	58	40·0	4	40	46·95	6	3	55·4	4	46	3·22	4	51	30·0	4	51	46·65
2			50·0			56·97		4	5·4			13·25			40·1			56·75
3		59	10·0		41	17·03			15·4			23·27		52	9·8		52	26·45
4			20·0			27·06			25·5			33·40			29·8			46·45
5			30·0			37·08			35·5			43·43		53	10·7		53	27·35
6			40·0			47·11			55·3		47	3·28			30·4			47·05
7			50·0			57·14		5	5·3			13·31			40·5			57·15
8	6	0	10·0		42	17·19			15·2			23·24			50·0		54	6·65
9			20·0			27·22			25·1			33·17		54	10·3			26·96
10			30·0			37·25			35·1			43·19			20·5			37·16
11			40·0			47·28			55·1		48	3·25			30·6			47·26
12			50·0			57·30		6	5·0			13·17			50·0		55	6·66
13		1	10·0		43	17·36			15·1			23·30		55	9·9			26·56
14			20·0			27·39			25·0			33·23			20·1			36·76
15			30·0			37·41			35·0			43·26			29·7			46·36
16			40·0			47·44			54·9		49	3·21			39·8			56·46
17			50·0			57·47		7	4·9			13·24	4	55	50·2	4	56	6·86
18		2	10·0		44	17·52			14·9			23·27	..		...	...		...
19			20·0			27·55			24·9			33·29	...		...	...		...
20			30·0			37·58	6	7	34·8	4	49	43·22	...		...	...		...
21			40·0			47·60	...		...	...		...	...		...	...		...
22	6	2	50·0	4	44	57·63	...		...	...		...	...		...	...		...

SIGNALS SENT TO AND RECEIVED FROM BELMONT—*continued.*

1875, JANUARY 3

SET 10

No. of signal	Time by chronometer 43			Pamplemousses sidereal time of signals *received* from Belmont			No. of signal	Time by chronometer 43			Pamplemousses sidereal time of signals *received* from Belmont			No. of signal	Time by chronometer 43			Pamplemousses sidereal time of signals *received* from Belmont		
	h.	m.	s.	h.	m.	s.		h.	m.	s.	h.	m.	s.		h.	m.	s.	h.	m.	s.
1	4	57	57·0	4	58	13·67	26	5	0	37·0	5	0	53·67	51	5	3	28·2	5	3	44·88
2		58	4·5			21·17	27			49·0		1	5·67	52			33·8			50·48
3			11·0			27·67	28			54·8			11·47	53			39·6			56·28
4			16·0			32·67	29		1	0·9			17·57	54			49·0		4	5·68
5			22·0			38·67	30			6·4			23·07	55			55·0			11·68
6			27·9			44·57	31			13·8			30·47	56		4	6·2			22·88
7			35·6			52·27	32			20·1			36·77	57			19·1			35·78
8			41·6			58·27	33			27·8			44·47	58			23·8			40·48
9			48·6		59	5·27	34			34·0			50·67	59			30·6			47·28
10			54·5			11·17	35			40·2			56·87	60			38·2			54·88
11		59	0·8			17·47	36			53·0		2	9·68	61			43·2			59·88
12			7·0			23·67	37			59·9			16·58	62			52·6		5	9·28
13			11·9			28·57	38		2	6·0			22·68	63		5	3·7			20·38
14			16·8			33·47	39			11·8			28·48	64			13·8			30·48
15			20·7			37·37	40			16·6			33·28	65			18·9			35·58
16			27·7			44·37	41			21·2			37·88	66			24·1			40·78
17			41·0			57·67	42			27·8			44·48	67			38·2			54·88
18			46·8	5	0	3·47	43			40·8			57·48	68			44·6		6	1·29
19			53·0			9·67	44			47·3		3	3·98	69			49·8			6·49
20			59·1			15·77	45			58·0			14·68	70			55·1			11·79
21	5	0	5·7			22·37	46			59·1			15·78	71		6	1·2			17·89
22			12·0			28·67	47		3	5·6			22·28	72			6·8			23·49
23			18·0			34·67	48			11·6			28·28	73			13·8			30·49
24			23·7			40·37	49			16·1			32·78	74	5	6	19·0	5	6	35·69
25	5	0	29·8	5	0	46·47	50	5	3	22·1	5	3	38·78	...		...			...	

SET 11

No. of signal	Time by chronometer 43			Pamplemousses sidereal time of signals *sent* to Belmont		
	h.	m.	s.	h.	m.	s.
1	7	21	20·1	7	21	37·13
2			29·7			46·73
3			39·6			56·63
4			49·8		22	6·83
5		22	19·9			36·93
6			29·7			46·73
7			39·8			56·83
8			49·9		23	6·93
9		23	9·8			26·83
10			19·9			36·93
11			29·9			46·93
12			39·2			56·23
13			50·1		24	7·13
14		24	20·0			37·04
15			50·0		25	7·04
16		25	10·0			27·04
17			20·1			37·14
18			50·1		26	7·14
19		26	40·0			57·04
20			51·0		27	8·04
21		27	9·3			26·34
22			19·4			36·44
23			29·8			46·84
24	7	27	40·2	7	27	57·24

SET 12

No. of signal	Time by chronometer 43			Pamplemousses sidereal time of signals *received* from Belmont			No. of signal	Time by chronometer 43			Pamplemousses sidereal time of signals *received* from Belmont		
	h.	m.	s.	h.	m.	s.		h.	m.	s.	h.	m.	s.
1	7	29	10·0	7	29	27·05	20	7	30	54·8	7	31	11·85
2			14·7			31·75	21		31	0·7			17·75
3			18·5			35·55	22			15·7			32·75
4			23·5			40·55	23			41·0			58·05
5			28·5			45·55	24			45·8		32	2·85
6			34·6			51·65	25			54·8			11·85
7			39·0			56·05	26			59·6			16·65
8			44·7		30	1·75	27		32	4·0			21·06
9			50·2			7·25	28			9·6			26·66
10			56·7			13·75	29			18·9			35·96
11		30	2·3			19·35	30			30·0			47·06
12			8·3			25·35	31			35·2			52·26
13			15·0			32·05	32			41·1			58·16
14			20·1			37·15	33			46·4		33	3·46
15			27·7			44·75	34			56·6			13·66
16			33·7			50·75	35		33	5·8			22·86
17			39·0			56·05	36			12·1			29·16
18			44·3		31	1·35	37			22·4			39·46
19	7	30	49·0	7	31	6·05	38	7	33	32·8	7	33	49·86

Comparisons of Chronometers at Belmont.

1875, January 2.

	h.	m.	s.		h.	m.	s.		h.	m.	s.		h.	m.	s.
'Walker 171'	2	26	50·0	(38)	4	10	54·0	'Walker 171'	2	32	15·0	(31)	3	53	20·0
„	2	29	10·0	(39)	4	25	13·5	(43)	2	35	11·0	(39)	4	32	34·0
„	2	31	23·5	(40)	4	5	2·0								

Time Determinations at Belmont.

Observations with Dr. Löw's Transit Instrument.

Observer, Dr. Pechüle; using the Electric Contact Chronometer 'Walker 171.'

Date, 1875	Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of transit over wire VI.	Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.			
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h. m. s.	p.	p.
Jan. 2	η Tauri	E	23·3	10·2	...	57·0	...	43·7	...	30·7	...	17·2	4·0	3 40 43·70	+ 7·8	− 14·1
															+ 11·3	− 10·8
	γ Hydri	„	9·3	24·2	53·8	38·6	23·4	52·7	22·4	7·7	52·2	21·8	35·5	3 49 52·80	+ 12·7	− 10·1
															+ 6·9	− 15·9
	α Horologii	„	21·3	4·7	53·7	48·2	43·0	32·0	21·2	15·7	10·1	59·1	42·5	4 10 31·93	+ 6·5	− 16·5
															+ 11·3	− 11·8
	Lacaille 1752	„	...	...	...	...	...	...	57·6	42·5	26·3	55·3	8·1	4 59 29·17	+ 11·4	− 11·9
															+ 6·8	− 16·6
	„	W	...	...	...	...	...	...	...	20·2	35·7	7·3	54·3	33·22	...	...
	β Orionis	„	36·8	49·0	...	1·2	...	13·3	...	25·5	...	37·8	...	5 9 13·40	+ 11·2	− 12·3
															+ 7·0	− 16·4
	δ Orionis	„	42·7	54·7	...	6·7	...	18·7	...	30·7	...	42·8	55·1	5 26 18·80	...	...
	ε Orionis	„	57·6	9·7	...	21·7	...	33·8	...	45·7	...	57·8	10·1	5 30 33·80	...	...
	α Columbæ	„	5·3	20·0	...	34·4	...	49·1	...	3·6	...	18·3	32·8	5 35 49·10	+ 8·1	− 15·4
															+ 10·3	− 13·2
	ζ Mensæ*	„	...	...	[35·6]	[11·0]	[23·0]	...	...	...	...	...	...	...	...	...
	„	E	...	...	46·0	...	...	...	..	...	...	...	...	...	...	...
	γ Canis maj.	„	24·2	11·8	...	59·2	...	46·6	...	34·2	...	21·7	8·9	6 58 46·63	...	...
	δ Canis maj.	„	39·3	25·8	...	12·4	...	58·8	...	45·5	...	32·1	19·1	7 3 58·89	[+ 6·3†	− 17·3]
															+ 8·4	− 15·3
	...	W	...	...	...	...	...	...	...	...	...	...	...	...	+ 8·3	− 15·3
															+ 11·1	− 12·7
Jan. 3 1st group	ε Eridani	E	17·4	5·2	...	53·0	...	40·5	...	28·4	...	16·1	3·8	3 27 40·61	+ 7·8	− 14·7
															+ 16·9	− 5·7
	17 Tauri	„	44·5	31·2	...	18·2	...	4·8	...	51·7	...	38·4	25·3	3 38 4·84	...	...
	η Tauri	„	20·5	7·4	...	54·3	...	41·0	...	27·8	...	14·5	...	3 40 40·95	+ 16·6	− 6·1
															+ 8·2	− 14·4
	γ Hydri	„	...	...	...	...	...	...	24·8	...	...	23·8	37·5	3 49 54·77	...	...
	„	W	...	...	...	...	...	...	...	...	...	...	15·2	58·45	+ 16·3	− 6·3
															+ 7·2	− 15·3
	o^1 Eridani	„	48·7	0·7	...	12·8	...	25·1	...	37·3	...	49·6	1·7	4 6 25·15	...	...
Jan. 3 2nd group	δ Orionis	W	40·4	52·4	...	4·4	...	16·6	...	28·7	...	40·7	52·8	5 26 16·60	+ 7·3	− 15·3
															+ 13·6	− 9·2
	ε Orionis	„	55·4	7·4	...	19·5	...	31·6	...	43·7	...	55·7	7·8	5 30 31·61	...	...
	ι Mensæ	„	58·3	1·3	43·5	4·3	24·7	...	...	...	...	...	...	5 44 6·76	+ 15·7	− 7·0
															+ 5·7	− 17·0
	„	E	10·5	7·7	25·7	5·2	...	...	...	...	...	...	...	2·34	+ 16·4	− 6·3
															+ 8·0	− 14·8
	ν Orionis	„	41·7	29·3	...	16·8	...	4·3	...	51·8	...	39·3	26·7	6 1 4·25	...	...
	6 Cancri	„	9·6	55·8	...	42·2	...	28·5	...	14·7	...	1·1	47·3	7 56 28·43	+ 5·4	− 17·7
															+ 16·5	− 6·7
	15 Argûs	„	31·6	18·2	...	5·1	...	51·9	...	38·7	...	25·6	12·2	8 2 51·87	...	...

* Owing to the uncertainty of the times given by the observer, this star has not been used.

[†] These levels discordant; rejected.

The Instrumental Corrections.

The value of one part of the level is $0^{s}\cdot111$; the *mean level* requires a correction of $+0^{p}\cdot15$ for Circle E and $-0^{p}\cdot15$ for Circle W for inequality of pivots. The correction for collimation was deduced from the observations of pole stars made in both positions of the instrument, and the azimuth correction by combining the various pole stars with the time stars. We thus find :—

Date, 1875	Level E	Level W	Collimation Circle W	Azimuth
	s.	s.	s.	s.
Jan. 2	−0·233	−0·266	−0·511	+0·717
„ 3, 1st group . . .	+0·103	+0·069	−0·438	−0·624
„ „ 2nd group . . .	−0·021	−0·054	„	−0·610

With these instrumental corrections we obtain the following results, where the concluded chronometer times of transit over wire VI. are identical with those already given with the observations :—

OBSERVER, DR. PECHÜLE ; CHRONOMETER, 'WALKER 171.'

Date, 1875	Epoch by chronometer and assumed *hourly* chronometer rate	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Chronometer rate to epoch	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m.			h. m. s.	s.	s.	h. m. s.	s.
Jan. 2	5 27·0	η Tauri	E	3 40 43·70	−0·11	−0·16	3 40 3·89	−39·54
	s.							
	+0·0625	γ Hydri	„	3 49 52·80	−0·10	+3·62	3 49 16·79	[39·53]
		α Horologii	„	4 10 31·93	−0·08	+0·77	4 9 53·07	39·55
		Lacaille 1752	„	4 59 29·17	−0·03	+3·76	4 58 53·29	[39·61]
		„	W	33·22	−0·03	−0·29	„	
		β Orionis	„	5 9 13·40	−0·02	−0·93	5 8 32·83	39·62
		δ Orionis	„	5 26 18·80	0·00	−1·00	5 25 38·21	39·59
		ε Orionis	„	5 30 33·80	0·00	−0·99	5 29 53·25	39·56
		α Columbæ	„	5 35 49·10	+0·01	−0·72	5 35 8·92	39·47
		γ Canis maj.	E	6 58 46·63	+0·10	+0·23	5 58 7·35	39·61
		δ Canis maj.	„	7 3 58·89	+0·10	+0·40	7 3 19·75	39·64
	h. m.							
Jan. 3 1st group	3 43·2	ε Eridani	E	3 27 40·61	−0·02	+0·69	3 27 3·13	−38·15
	s.							
	+0·0625	17 Tauri	„	3 38 4·84	−0·01	+1·07	3 37 27·82	38·08
		η Tauri	„	3 40 40·95	0·00	+1·07	3 40 3·87	38·15
		γ Hydri	„	3 49 54·77	+0·01	+0·11	3 49 16·73	[38·16]
		„	W	58·45	+0·01	−3·57	„	
		o¹ Eridani	„	4 6 25·15	+0·02	−0·27	4 5 46·64	38·26
	h. m.							
Jan. 3 2nd group	6 35·5	δ Orionis	W	5 26 16·60	−0·07	−0·27	5 25 38·21	−38·05
	s.							
	+0·0625	ε Orionis	„	5 30 31·61	−0·07	−0·27	5 29 53·25	38·02
		ι Mensæ	„	5 44 6·76	−0·05	−5·02	5 43 23·71	[37·98]
		„	E	2·34	−0·05	−0·60	„	
		ν Orionis	„	6 1 4·25	−0·04	+0·77	6 0 27·15	37·83
		6 Cancri	„	7 56 28·43	+0·08	+0·97	7 55 51·54	37·94
		15 Argûs	„	8 2 51·87	+0·09	+0·39	8 2 14·27	38·08

Taking the means of the separate groups, we obtain :—

Date	Epoch by chronometer	Chronometer correction to local sidereal time	
	h. m.	s.	s.
1875, Jan. 2	5 27·0	Circle E −39·585 „ W 39·560	−39·57
„ „ 3, 1st group	3 43·2	Circle E −38·127 „ W 38·260	−38·19
„ „ 3, 2nd group	6 35·5	Circle E −37·950 „ W 38·035	−37·99

On January 3, 1875, the day of the exchange of telegraphic signals between Belmont and Pamplemousses, by taking the mean of the two groups of time determinations, and calculating the rate of the chronometer from this mean and the determination on January 2, we have as the final correction of the Belmont chronometer :—

At h. m. 5 9·3 by chronometer, correction to local sidereal time s. −38·09 ; hourly rate s. +0·0624

Then, from the comparisons of chronometers before leaving Belmont and the corrections deduced at Pamplemousses (p. 133), we obtain the difference of longitude as it results from the transport of chronometers :—

Time by		Belmont		Time by		Pamplemousses		Resulting difference of longitude
	h. m. s.		h. m. s.		h. m. s.		h. m. s.	h. m. s.
'Walker 171'	2 26 50·0	M.T.	7 38 41·18	(38)	4 10 54·0	M.T.	7 38 12·77	0 0 28·41
„	2 29 10·0	„	7 41 0·80	(39)	4 25 13·5	„	7 40 30·90	29·90
„	2 31 23·5	„	7 43 13·93	(40)	4 5 2·0	„	7 42 44·86	29·07
„	2 32 15·0	„	7 44 5·30	(31)	3 53 20·0	„	7 43 37·27	28·03
(43)	2 35 11·0	S.T.	2 35 51·90	(39)	4 32 34·0	S.T.	2 35 23·67	28·23
							Mean	0 0 28·73
							Personal equation	+ 0·27
							Belmont east of Pamplemousses	0 0 29·00

The following are the times of the bursting of the rockets as recorded by Dr. Pechüle. The corresponding observations at Pamplemousses are here reproduced, so that we have again the difference of longitude

Time by 'Walker 171'	Belmont sidereal time	Pamplemousses sidereal time	Resulting difference of longitude
h. m. s.	h. m. s.	h. m. s.	h. m. s.
6 24 30·2	6 23 50·69	6 23 22·04	0 0 28·65
6 26 45·3	6 26 5·79	6 25 37·35	28·44
6 28 49·1	6 28 9·59	6 27 40·95	28·64
6 32 55·0	6 32 15·50	6 31 46·76	28·74
6 35 10·5	6 34 31·00	6 34 2·07	28·93
		Belmont east of Pamplemousses	0 0 28·68

It has been assumed that the personal equation in observing rockets is the same as in taking transits. These two determinations of the difference of longitude are given merely as confirmations of the telegraphic result.

Operations at Belmont.

In the following tables will be found the chronometer and local sidereal times of despatch and receipt of signals at Belmont, and, to give immediately the difference of longitude, the Pamplemousses sidereal times of receipt and despatch of the same signals at that end of the line are here repeated :—

1875, January 3

Set 1

Number of signal	Time by 'Walker 171'	Belmont sidereal time ; signals *received*	Corresponding Pamplemousses sidereal time ; signals *sent*	Resulting longitude, Belmont east of Pamplemousses
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	21 42 14·5	21 41 35·95	21 41 7·53	0 0 28·42
2	34·2	55·65	27·58	28·07
3	44·3	42 5·75	37·61	28·14
4	54·5	15·95	47·64	28·31
5	43 14·4	35·85	42 7·69	28·16
6	24·6	46·05	17·72	28·33
7	34·5	55·95	27·75	28·20
8	44·5	43 5·95	37·77	28·18
9	54·5	15·95	47·80	28·15
10	44 14·6	36·05	43 7·86	28·19
11	24·5	45·95	17·88	28·07
12	34·7	56·15	27·91	28·24
13	44·7	44 6·15	37·94	28·21
14	54·7	16·15	47·97	28·18
15	45 15·0	36·45	44 8·02	28·43
16	24·9	46·35	18·05	28·30
17	34·8	56·25	28·07	28·18
18	45·0	45 6·45	38·10	28·35
19	21 45 55·0	21 45 16·45	21 44 48·13	28·32

Set 2

Number of signal	Time by 'Walker 171'	Belmont sidereal time ; signals *sent*	Corresponding Pamplemousses sidereal time ; signals *received*	Resulting longitude, Belmont east of Pamplemousses
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	21 47 10·0	21 46 31·45	21 46 4·14	[0 0 27·31*]
2	20·0	41·45	13·16	0 0 28·29
3	30·0	51·45	22·99	28·46
4	40·0	47 1·45	32·92	28·53
5	50·0	11·45	43·05	28·40
6	48 10·0	31·45	47 3·51	[27·94*]
7	20·0	41·45	13·54	[27·91*]
8	30·0	51·45	23·06	28·39
9	40·0	48 1·45	33·09	28·36
10	50·0	11·45	43·12	28·33
11	49 10·0	31·45	48 3·07	28·38
12	20·0	41·45	13·00	28·45
13	40·0	49 1·45	33·05	28·40
14	50·0	11·45	41·98	[29·47*]
15	50 10·0	31·45	49 2·84	28·61
16	20·0	41·45	12·86	28·59
17	30·0	51·45	22·89	28·56
18	40·0	50 1·45	33·02	28·43
19	21 50 50·0	21 50 11·45	21 49 42·94	28·51

[*] Discordant ; rejected.

1875, JANUARY 3

SET 3

Number of signal	Time by 'Walker 171'	Belmont sidereal time ; signals *received*	Corresponding Pamplemousses sidereal time ; signals *sent*	Resulting longitude, Belmont east of Pamplemousses
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	21 52 16·0	21 51 37·46	21 51 8·98	0 0 28·48
2	25·3	46·76	18·70	28·06
3	35·5	56·96	28·63	28·33
4	45·0	52 6·46	33·65	[32·81*]
5	56·0	17·46	49·19	28·27
6	53 16·3	37·76	52 9·04	28·72
7	26·3	47·76	19·37	28·39
8	36·3	57·76	29·20	28·56
9	46·2	53 7·66	39·12	28·54
10	56·3	17·76	49·25	28·51
11	54 16·3	37·76	53 9·51	28·25
12	26·3	47·76	19·23	28·53
13	36·2	57·66	28·96	28·70
14	46·2	54 7·66	38·89	28·77
15	57·3 (?)	18·76 (?)	49·31	[29·45*
16	55 18·5	39·96	54 9·37	30·59
17	28·3	49·76	19·30	30·46
18	38·2	59·66	29·42	30·24
19	48·7	55 10·16	39·55	30·61
20	21 55 58·3	21 55 19·76	21 54 49·58	30·18]

SET 4

Number of signal	Time by 'Walker 171'	Belmont sidereal time ; signals *sent*	Corresponding Pamplemousses sidereal time ; signals *received*	Resulting longitude, Belmont east of Pamplemousses
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	21 57 12·0	21 56 33·46	21 56 5·00	0 0 28·46
2	25·0	46·46	18·23	28·23
3	40·0	57 1·46	33·07	28·39
4	51·0	12·46	44·10	28·36
5	58 3·0	24·46	56·14	28·32
6	14·0	35·46	57 7·07	28·39
7	26·3	47·76	19·40	28·36
8	39·8	58 1·26	32·94	28·32
9	56·9	18·36	39·96	[38·40*]
10	59 11·9	33·36	58 4·82	28·54
11	26·0 (?)	47·46 (?)	19·36	[28·10*]
12	37·2	58·66	30·39	28·27
13	48·2	59 9·66	41·42	28·24
14	59·0	20·46	52·15	28·31
15	22 0 6·0	27·46	58·87	28·59
16	12·0	33·46	59 4·99	28·47
17	18·9	40·36	11·91	28·45
18	30·3	51·76	23·54	28·22
19	43·8	22 0 5·26	36·98	28·28
20	53·0	14·46	45·90	28·56
21	22 1 2·9	22 0 24·36	21 59 55·93	28·43

[*] Discordant, or marked doubtful by observer ; rejected.

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SET 5

Number of signal	Time by 'Walker 171'	Belmont sidereal time; signals *received*	Corresponding Pamplemousses sidereal time; signals *sent*	Resulting longitude, Belmont east of Pamplemousses
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	22 2 28·0	22 1 49·47	22 1 20·87	0 0 28·60
2	37·2	58·67	30·50	28·17
3	58·0	2 19·47	50·95	28·52
4	3 17·8	39·27	2 10·91	28·36
5	28·0	49·47	20·93	28·54
6	38·0	59·47	31·06	28·41
7	48·2	3 9·67	41·29	28·38
8	58·2	19·67	51·32	28·35
9	4 17·2	38·67	3 10·37	28·30
10	26·5	47·97	19·59	28·38
11	38·3	59·77	31·23	28·54
12	58·7	4 20·17	51·48	28·69
13	5 19·0	40·47	4 11·94	28·53
14	38·6	5 0·07	31·49	28·58
15	47·3	8·77	40·41	28·36
16	53·0	14·47	46·43	28·04
17	22 5 58·7	22 5 20·17	22 4 52·05	28·12

SET 6

Number of signal	Time by 'Walker 171'	Belmont sidereal time; signals *sent*	Corresponding Pamplemousses sidereal time; signals *received*	Resulting longitude, Belmont east of Pamplemousses
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	22 6 37·0	22 5 58·47	22 5 27·04	[0 0 31·43*]
2	48·7	6 10·17	41·88	0 0 28·29
3	58·0	19·47	51·01	28·46
4	7 8·2	29·67	6 1·23	28·44
5	16·8	38·27	9·66	28·61
6	24·5	45·97	17·38	28·59
7	34·0	55·47	27·10	28·37
8	41·5	7 2·97	34·53	28·44
9	52·7	14·17	45·47	28·70
10	8 2·5	23·97	55·39	28·58
11	8·0	29·47	7 5·92	[23·55*]
12	21·3	42·77	14·44	28·33
13	32·8	54·27	25·78	28·49
14	40·5	8 1·97	33·90	28·07
15	50·3	11·77	43·72	28·05
16	9 0·3	21·77	53·25	28·52
17	8·2	29·67	8 1·37	28·30
18	22·5	43·97	15·61	28·36
19	30·8	52·27	24·03	28·24
20	40·0	9 1·47	33·16	28·31
21	54·8	16·27	48·10	28·17
22	10 2·5	23·97	55·42	28·55
23	9·0	30·47	9 2·14	28·33
24	16·3	37·77	9·46	28·31
25	26·0	47·47	19·18	28·29
26	22 10 34·0	22 9 55·47	22 9 27·21	28·26

[*] Discordant, or marked doubtful by observer; rejected.

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SET 7

Number of signal	Time by 'Walker 171'	Belmont sidereal time; signals *received*	Corresponding Pamplemousses sidereal time; signals *sent*	Resulting longitude, Belmont east of Pamplemousses
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	4 41 53·5	4 41 15·38	4 40 46·95	0 0 28·43
2	42 2·4	24·28	56·97	[27·31*]
3	23·6	45·48	41 17·03	28·45
4	33·6	55·48	27·06	28·42
5	43·6	42 5·48	37·08	28·40
6	53·6	15·48	47·11	28·37
7	43 3·7	25·58	57·14	28·44
8	23·7	45·58	42 17·19	28·39
9	33·8	55·68	27·22	28·46
10	43·7	43 5·58	37·25	28·33
11	53·8	15·68	47·28	28·40
12	44 3·8	25·68	57·30	28·38
13	23·8	45·68	43 17·36	28·32
14	33·9	55·78	27·39	28·39
15	43·9	44 5·78	37·41	28·37
16	54·0	15·88	47·44	28·44
17	45 4·0	25·88	57·47	28·41
18	24·1	45·99	44 17·52	28·47
19	34·1	55·99	27·55	28·44
20	44·1	45 5·99	37·58	28·41
21	54·2	16·09	47·60	28·49
22	4 46 4·2	4 45 26·09	4 44 57·63	28·46

SET 8

Number of signal	Time by 'Walker 171'	Belmont sidereal time; signals *sent*	Corresponding Pamplemousses sidereal time; signals *received*	Resulting longitude, Belmont east of Pamplemousses
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	4 47 10·0	4 46 31·89	4 46 3·22	0 0 28·67
2	20·0	41·89	13·25	28·64
3	30·0	51·89	23·27	28·62
4	40·0	47 1·89	33·40	28·49
5	50·0	11·89	43·43	28·46
6	48 10·0	31·89	47 3·28	28·61
7	20·0	41·89	13·31	28·58
8	30·0	51·89	23·24	28·65
9	40·0	48 1·89	33·17	28·72
10	50·0	11·89	43·19	28·70
11	49 10·0	31·89	48 3·25	28·64
12	20·0	41·89	13·17	28·72
13	30·0	51·89	23·30	28·59
14	40·0	49 1·89	33·23	28·66
15	50·0	11·89	43·26	28·63
16	50 10·0	31·89	49 3·21	28·68
17	20·0	41·89	13·24	28·65
18	30·0	51·89	23·27	28·62
19	40·0	50 1·89	33·29	28·60
20	4 50 50·0	4 50 11·89	4 49 43·22	28·67

[*] Discordant; rejected.

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SET 9

Number of signal	Time by 'Walker 171'	Belmont sidereal time; signals *received*	Corresponding Pamplemousses sidereal time; signals *sent*	Resulting longitude, Belmont east of Pamplemousses
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	4 52 53·2	4 52 15·09	4 51 46·65	0 0 28·44
2	53 3·5	25·39	56·75	28·64
3	33·2	55·09	52 26·45	28·64
4	53·0	53 14·89	46·45	28·44
5	54 33·5	55·39	53 27·35	28·04
6	53·6	54 15·49	47·05	28·44
7	55 3·6	25·50	57·15	28·35
8	13·2	35·10	54 6·65	28·45
9	33·6	55·50	26·96	28·54
10	43·6	55 5·50	37·16	28·34
11	53·7	15·60	47·26	28·34
12	56 13·2	35·10	55 6·66	28·44
13	33·1	55·00	26·56	28·44
14	43·5	56 5·40	36·76	28·64
15	52·7	14·60	46·36	28·24
16	57 3·0	24·90	56·46	28·44
17	4 57 13·5	4 56 35·40	4 56 6·86	28·54

SET 10

Number of signal	Time by 'Walker 171'	Belmont sidereal time; signals *sent*	Corresponding Pamplemousses sidereal time; signals *received*	Resulting longitude, Belmont east of Pamplemousses
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	4 59 20·0	4 58 41·90	4 58 13·67	0 0 28·23
2	27·8	49·70	21·17	28·53
3	34·3	56·20	27·67	28·53
4	39·3	59 1·20	32·67	28·53
5	45·5	7·40	38·67	28·73
6	51·5	13·40	44·57	28·83
7	58·9	20·80	52·27	28·53
8	5 0 4·7	26·60	58·27	28·33
9	12·0	33·90	59 5·27	28·63
10	17·9	39·80	11·17	28·63
11	23·9	45·80	17·47	28·33
12	30·1	52·00	23·67	28·33
13	35·2	57·10	28·57	28·53
14	40·0	5 0 1·90	33·47	28·43
15	43·9	5·80	37·37	28·43
16	50·9	12·80	44·37	28·43
17	1 4·2	26·10	57·67	28·43
18	10·0	31·90	5 0 3·47	28·43
19	16·1	38·00	9·67	28·33
20	22·2	44·10	15·77	28·33
21	28·7	50·60	22·37	28·23
22	35·2	57·10	28·67	28·43
23	41·2	1 3·10	34·67	28·43
24	47·0	8·90	40·37	28·53
25	53·0	14·90	46·47	28·43
26	5 2 0·2	5 1 22·10	5 0 53·67	28·43

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SET 10—*continued.*

Number of signal	Time by 'Walker 171'	Belmont sidereal time; signals *sent*	Corresponding Pamplemousses sidereal time; signals *received*	Resulting longitude, Belmont east of Pamplemousses
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
27	5 2 12·2	5 1 34·10	5 1 5·67	0 0 28·43
28	18·0	39·90	11·47	28·43
29	24·1	46·00	17·57	28·43
30	29·5	51·40	23·07	28·33
31	36·9	58·80	30·47	28·33
32	43·5	2 5·40	36·77	28·63
33	50·9	12·80	44·47	28·33
34	57·1	19·00	50·67	28·33
35	3 3·5	25·40	56·87	28·53
36	16·2	38·10	2 9·68	28·42
37	23·0	44·90	16·58	28·32
38	29·5	51·40	22·68	28·72
39	35·0	56·90	28·48	28·42
40	39·9	3 1·80	33·28	28·52
41	44·8	6·70	37·88	28·82
42	51·0	12·90	44·48	28·42
43	4 3·9	25·80	57·48	28·32
44	10·5	32·40	3 3·98	28·42
45	16·2	38·10	14·68	[23·42*]
46	22·5	44·40	15·78	28·62
47	28·9	50·80	22·28	28·52
48	35·0	56·90	28·28	28·62
49	39·5	4 1·41	32·78	28·63
50	45·5	7·41	38·78	28·63
51	51·5	13·41	44·88	28·53
52	57·1	19·01	50·48	28·53
53	5 3·0	24·91	56·28	28·63
54	12·5	34·41	4 5·68	28·73
55	18·5	40·41	11·68	28·73
56	29·7	51·61	22·88	28·73
57	42·7	5 4·61	35·78	28·83
58	47·0	8·91	40·48	28·43
59	54·0	15·91	47·28	28·63
60	6 1·5	23·41	54·88	28·53
61	6·5	28·41	59·88	28·53
62	16·0	37·91	5 9·28	28·63
63	27·0	48·91	20·38	28·53
64	37·0	58·91	30·48	28·43
65	42·2	6 4·11	35·58	28·53
66	47·5	9·41	40·78	28·63
67	7 1·5	23·41	54·88	28·53
68	7·5	29·41	6 1·29	28·12
69	13·0	34·91	6·49	28·42
70	18·5	40·41	11·79	28·62
71	24·5	46·41	17·89	28·52
72	30·0	51·91	23·49	28·42
73	37·0	58·91	30·49	28·42
74	5 7 42·2	5 7 4·11	5 6 35·69	28·42

[*] Discordant; rejected.

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SET 11

Number of signal	Time by 'Walker 171'	Belmont sidereal time; signals *received*	Corresponding Pamplemousses sidereal time; signals *sent*	Resulting longitude, Belmont east of Pamplemousses
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	7 22 43·6	7 22 5·65	7 21 37·13	0 0 28·52
2	53·0	15·05	46·73	28·32
3	23 3·0	25·05	56·63	28·42
4	13·5	35·55	22 6·83	28·72
5	43·5	23 5·55	36·93	28·62
6	52·7	14·75	46·73	28·02
7	24 3·5	25·55	56·83	28·72
8	13·5	35·55	23 6·93	28·62
9	33·5	55·55	26·83	28·72
10	43·5	24 5·55	36·93	28·62
11	53·1	15·15	46·93	28·22
12	25 2·5	24·55	56·23	28·32
13	13·5	35·55	24 7·13	28·42
14	43·5	25 5·55	37·04	28·51
15	26 13·5	35·55	25 7·04	28·51
16	33·5	55·55	27·04	28·51
17	43·5	26 5·55	37·14	28·41
18	27 13·5	35·55	26 7·14	28·41
19	28 3·5	27 25·55	57·04	28·51
20	14·5	36·55	27 8·04	28·51
21	32·5	54·55	26·34	28·21
22	43·6	28 5·65	36·44	[29·21*]
23	53·5	15·55	46·84	28·71
24	7 29 3·5	7 28 25·55	7 27 57·24	28·31

SET 12

Number of signal	Time by 'Walker 171'	Belmont sidereal time; signals *sent*	Corresponding Pamplemousses sidereal time; signals *received*	Resulting longitude, Belmont east of Pamplemousses
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	7 30 33·5	7 29 55·56	7 29 27·05	0 0 28·51
2	38·0	30 0·06	31·75	28·31
3	42·2	4·26	35·55	28·71
4	47·0	9·06	40·55	28·51
5	52·1	14·16	45·55	28·61
6	58·0	20·06	51·65	28·41
7	31 2·5	24·56	56·05	28·51
8	8·1	30·16	30 1·75	28·41
9	14·0	36·06	7·25	28·81
10	20·2	42·26	13·75	28·51
11	26·0	48·06	19·35	28·71
12	32·0	54·06	25·35	28·71
13	38·5	31 0·56	32·05	28·51
14	43·5	5·56	37·15	28·41
15	51·2	13·26	44·75	28·51
16	57·2	19·26	50·75	28·51
17	32 2·5	24·56	56·05	28·51
18	7·8	29·86	31 1·35	28·51
19	12·6	34·66	6·05	28·61
20	7 32 18·0	7 31 40·06	7 31 11·85	28·21

[*] Discordant; rejected.

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SET 12—*continued*

Number of signal	Time by 'Walker 171'	Belmont sidereal time; signals *sent*	Corresponding Pamplemousses sidereal time; signals *received*	Resulting longitude, Belmont east of Pamplemousses
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
21	7 32 23·9	7 31 45·96	7 31 17·75	0 0 28·21
22	39·1	32 1·16	32·75	28·41
23	33 4·6	26·66	58·05	28·61
24	9·4	31·46	32 2·85	28·61
25	18·1	40·16	11·85	28·31
26	23·0	45·06	16·65	28·41
27	27·6	49·66	21·06	28·60
28	33·0	55·06	26·66	28·40
29	42·5	33 4·56	35·96	28·60
30	53·5	15·56	47·06	28·50
31	59·0	21·06	52·26	28·80
32	34 4·5	26·56	58·16	28·40
33	10·2	32·26	33 3·46	28·80
34	20·0	42·06	13·66	28·40
35	29·5	51·56	22·86	28·70
36	35·5	57·56	29·16	28·40
37	46·0	34 8·06	39·46	28·60
38	7 34 56·5	7 34 18·56	7 33 49·86	28·70

Taking the means of the results of the foregoing sets, we now obtain :—

Difference of Longitude by Signals sent from Belmont and recorded at Pamplemousses.

Date	Set	No. of signals	Resulting longitude, Belmont east of Pamplemousses	
			h. m. s.	h. m. s.
1875, Jan. 3, 1st series . . .	2	15	0 0 28·446	
	4	19	28·378	0 0 28·401
	6	24	28·378	
1875, Jan. 3, 2nd series . . .	8	20	0 0 28·630	
	10	73	28·496	0 0 28·550
	12	38	28·525	

Difference of Longitude by Signals sent from Pamplemousses and recorded at Belmont.

Date	Set	No. of signals	Resulting longitude, Belmont east of Pamplemousses	
			h. m. s.	h. m. s.
1875, Jan. 3, 1st series . .	1	19	0 0 28·233	
	3	13	28·470	0 0 28·369
	5	17	28·404	
1875, Jan. 3, 2nd series . . .	7	21	0 0 28·413	
	9	17	28·435	0 0 28·440
	11	23	28·472	

Combining these results, on the supposition that the current time is the same in both directions, we have :—

		h. m. s.		s.
1875, Jan. 3, 1st series	Belmont east of Pamplemousses	0 0 28·385	Current time	−0·016
„ „ 2nd series	„ „ „	28·495	„	−0·055

Or—

	h.	m.	s.	s.
Belmont east of Pamplemousses	0	0	28·44	±0·017
Correction for personal equation between Dr. Pechüle and Mr. Gill—				
In observing transits			+0·27	±0·100
In sending and receiving signals			+0·09	

Therefore, finally :—

	h.	m.	s.	s.
Belmont east of Pamplemousses	0	0	28·80	±0·10

CHAPTER VII.

DETERMINATION OF THE DIFFERENCE OF PERSONAL EQUATION BETWEEN DR. PECHÜLE AND MR. GILL IN FINDING THE TIME WITH THEIR RESPECTIVE INSTRUMENTS AT BELMONT, AND IN RECORDING TELEGRAPHIC SIGNALS.

To find the personal equation in observing transits between Dr. Pechüle and Mr. Gill, the former observed with the transit instrument of the German Expedition (Dr. Löw's transit) in the meridian of the reversing transit instrument, while Mr. Gill used the Troughton and Simms' altazimuth in the observatory 46·5 feet further west. Experiments were also made which gave their relative personal equation both in recording the beats of a Siemens' relay and the taps of the transmitting key. In the following pages are given all the observations and comparisons as well as the final results.

Operations at Belmont.

Observations for difference of personal equation in time determinations between Dr. Pechüle and Mr. Gill with their respective instruments :—

Chronometer Comparisons.

(31) Dr. Pechüle	(43) Mr. Gill	(31) Dr. Pechüle	(43) Mr. Gill
h. m. s.	h. m. s.	h. m. s.	h. m. s.
5 47 52·0	4 33 36·0	9 7 35·0	7 53 51·5
5 50 53·5	4 36 38·0	9 13 42·0	7 59 59·5
		9 16 44·0	8 3 2·0

Observations taken with Dr. Löw's Transit Instrument.
Observer, Dr. Pechüle; Chronometer 31.

Date, 1875	Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of transit over wire VI.			Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.					
			s.	s	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Jan. 4	γ Mensæ	E	...	59·5	25·8	8·7	51·7	17·3	42·8	26·2	8·2	34·2	...	6	50	17·08	+ 12·2	− 10·3
																	+ 9·6	− 12·8
	α Orionis	„	15·3	3·2	...	51·1	...	38·8	...	26·7	...	14·6	2·5	7	1	38·86	+ 7·1	− 15·3
																	+ 13·3	− 9·2
	1 Geminorum	„	23·6	10·5	...	57·3	...	44·2	...	31·1	...	17·9	4·7	7	9	44·16	...	...
	θ Leporis	„	20·6	8·2	...	55·8	...	43·2	...	30·8	...	18·3	5·8	7	13	43·22	+ 13·9	− 8·7
																	+ 10·0	− 12·6
	κ Columbæ	„	2·7	48·1	...	33·3	...	18·7	...	4·0	...	49·2	34·3	7	25	18·59	+ 10·2	− 12·3
																	+ 13·6	− 9·0
	ϵ Geminorum	W	41·8	...	...	8·3	...	21·7	...	34·9	...	48·3	1·8	7	49	21·72	...	...
	α Canis maj.	„	8·4	20·9	...	33·5	...	46·3	...	58·7	...	11·2	24·0	7	52	46·17	...	...
	ζ Mensæ	„	6·0	20·1	...	34·5	59·2	...	...	...	...	...	...	8	3	49·05	+ 9·2	− 13·4
																	+ 12·7	− 10·0
	„	E	27·3	12·7	23·0	58·4	33·7	...	...	...	...	...	...			43·93	+ 9·4	− 13·3
																	+ 14·0	− 8·7
	C Puppis	„	58·4	...	...	...	...	...	...	53·7	...	37·2	20·9	8	13	9·70	+ 12·7	− 10·0
																	+ 10·6	− 12·2
	51 Geminorum	„	50·8	38·3	...	25·8	...	13·1	...	0·6	...	48·0	35·3	8	19	13·10	+ 8·8	− 14·0
																	+ 12·6	− 10·1
	π Argûs	„	31·2	16·2	...	1·1	...	46·0	...	31·1	...	15·7	0·7	8	25	45·97	+ 13·2	− 9·5
																	+ 11·3	− 11·3
	β Canis min.	„	58·3	45·9	...	33·9	...	21·7	...	9·6	...	57·3	45·1	8	33	21·66	+ 8·8	− 14·0
																	+ 13·2	− 9·5
	π^1 Puppis	„	39·9	26·7	...	13·7	...	0·4	...	47·5	...	34·4	21·2	8	42	0·52	+ 14·0	− 8·9
																	+ 11·0	− 11·9
	9 Puppis	„	31·7	19·7	...	7·1	...	54·8	...	42·5	...	30·1	17·6	8	58	54·76	+ 13·6	− 9·2
																	+ 10·7	− 12·3

OBSERVATIONS WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH USED AS A TRANSIT INSTRUMENT. THE REVERSAL WAS EFFECTED BY TURNING THE AZIMUTH CIRCLE 180°. OBSERVER, MR. GILL; CHRONOMETER 43.

Date, 1875	Name of star	Position of circle	Level readings		Seconds by chronometer of transit over wires I.	II.	III.	IV.	V.	Concluded chronometer time of transit over wire III. h.	m.	s.	Level readings E p.	W p.
					s.	s.	s.	s.	s.					
Jan. 4	1 Geminorum	W	...	...	21·0	35·4	50·0	4·1	18·5	5	55	50·05	...	...
	θ Leporis	,,	...	...	14·3	28·1	42·4	55·8	9·3	5	59	42·21	18·4 21·5	13·5 10·5
	κ Columbæ	,,	...	...	42·0	58·1	14·7	30·4	46·5	6	11	14·62	19·0 20·5	13·0 11·2
	ϵ Geminorum	,,	...	...	4·4	19·1	34·0	48·4	3·0	6	35	34·03	...	...
	α Canis majoris	,,	...	...	22·5	...	50·1	...	17·5	6	38	50·23	19·1 20·8	12·6 11·1
	ζ Mensæ	,,	...	...	57·0	...	...	...	...	6	48	42·25	...	...
	,,	E	...	...	43·5	23·0	...	...	...	6	48	58·71	28·0 16·0	3·8 16·0
	C Puppis	,,	...	...	...	...	...	56·8	39·5	6	59	14·60	...	...
	51 Geminorum	,,	...	...	59·4	[*46·5?]	31·7	18·0	4·1	7	5	31·54	16·0 27·5	16·2 4·5
	π Argûs	,,	...	...	28·0	11·5	54·6	38·1	21·6	7	11	54·48	27·2 15·8	4·7 16·2
	β Canis minoris	,,	...	...	7·9	54·4	41·1	27·5	14·1	7	19	40·77	16·2 26·2	15·3 †5·8
	n^1 Puppis	,,	...	...	44·1	29·4	15·0	1·5	46·5	7	28	15·05	25·0 18·6	7·2 13·1
	β Geminorum	,,	...	...	...	...	...	47·4	32·4	7	37	2·18	...	...
	9 Puppis	,,	...	...	41·4	27·8	14·0	0·5	47·0	7	45	13·91	20·0 24·0	12·3 8·1

[*] Discordant; rejected. † 15ᵖ·8 in original.

For the observations with Dr. Löw's transit instrument, we then have :—

Date	Level E	Level W	Collimation, Circle W	Azimuth
	s.	s.	s.	s.
1875, Jan. 4	−0·004	−0·037	−0·407	−1·618

OBSERVER, DR. PECHÜLE; CHRONOMETER 31.

Date, 1875	Epoch by chronometer and assumed *hourly* chronometer rate	Name of star	Position of circle	Concluded chronometer time of transit over wire VI. h.	m.	s.	Chronometer rate to epoch	Sum of instrumental corrections	R.A. of star, including daily aberration h.	m.	s.	Chronometer correction h.	m.	s.
							s.	s.						
Jan. 4	$7^h\ 59^m\ 0^s$ +9·956	γ Mensæ	E	6	50	17·08	−11·40	− 4·02	5	36	56·57	[−1	13	5·09]
		α Orionis	,,	7	1	38·86	− 9·51	+ 1·16	5	48	25·28	−1	13	5·23
		1 Geminorum	,,	7	9	44·16	− 8·17	+ 1·65	5	56	32·40			5·24
		θ Leporis	,,	7	13	43·22	− 7·51	+ 0·57	6	0	31·11			5·17
		κ Columbæ	,,	7	25	18·59	− 5·59	− 0·01	6	12	7·83			5·16
		ϵ Geminorum	W	7	49	21·72	− 1·60	+ 0·79	6	36	15·62			5·29
		α Canis majoris	,,	7	52	46·17	− 1·03	− 0·35	6	39	39·40			5·39
		ζ Mensæ	,,	8	3	49·05	+ 0·80	−11·34	6	50	33·16			[5·36]
		,,	E			43·93	+ 0·79	− 6·20		,,				
		C Puppis	,,	8	13	9·70	+ 2·35	− 0·28	7	0	6·60			5·17
		51 Geminorum	,,	8	19	13·10	+ 3·35	+ 1·42	7	6	12·71			5·16
		π Argûs	,,	8	25	45·97	+ 4·44	− 0·07	7	12	45·07			5·27
		β Canis minoris	,,	8	33	21·66	+ 5·70	+ 1·19	7	20	23·36			5·19
		n^1 Puppis	,,	8	42	0·52	+ 7·14	+ 0·34	7	29	2·82			5·18
		9 Puppis	,,	8	58	54·76	+ 9·94	+ 0·61	7	46	0·11			5·20

Mr. Gill's observations with the Troughton and Simms' altazimuth, on reduction by the method already described, give the following results :—

Assumed chronometer rate $+0^{s}\cdot151$ per hour (used only for calculation of azimuth).

	Level	Collimation	Azimuth
		s.	s.
Circle E	Interpolated	−1·090	+10·606
„ W	$-0^{s}\cdot827$	+1·090	+10·295

OBSERVER, MR. GILL; CHRONOMETER 43.

Date, 1875	Epoch by chronometer	Name of star	Position of circle	Concluded chronometer time of transit over wire III.	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m.			h. m. s.	s.	h. m. s.	s.
Jan. 4	6 48·6	1 Geminorum	W	5 55 50·05	− 7·38	5 56 32·40	+49·73
		θ Leporis	„	5 59 42·21	− 0·71	6 0 31·11	49·61
		κ Columbæ	„	6 11 14·62	+ 3·72	6 12 7·83	49·49
		ϵ Geminorum	„	6 35 34·03	− 7·77	6 36 15·62	49·36
		α Canis majoris	„	6 38 50·23	− 0·41	6 39 39·40	49·58
		C Puppis	E	6 59 14·60	+ 2·23	7 0 6·60	49·77
		51 Geminorum	„	7 5 31·54	− 8·50	7 6 12·71	49·67
		π Argûs	„	7 11 54·48	+ 0·98	7 12 45·07	49·61
		β Canis minoris	„	7 19 40·77	− 7·07	7 20 23·36	49·66
		n^{1} Puppis	„	7 28 15·05	− 1·89	7 29 2·82	49·66
		β Geminorum	„	7 37 2·18	−10·90	7 37 41·14	49·86
		9 Puppis	„	7 45 13·91	− 3·56	7 46 0·11	49·76

On taking the means we find for Dr. Pechüle, observing with Dr. Löw's transit instrument and chronometer 31 :—

Epoch by chronometer	Chronometer correction to local sidereal time			Adopted *hourly* rate
h. m. s.	h. m. s.		h. m. s.	s.
7 59 0	Circle E −1 13 5·197	}	−1 13 5·27	+9·956
	„ W 5·340	}		

While Mr. Gill's observations with the Troughton and Simms' altazimuth and chronometer 43 result in :—

Epoch by chronometer	Chronometer correction to local sidereal time			Adopted *hourly* rate
h. m.	s.		s.	s.
6 48·6	Circle E +49·713	}	+49·63	+0·162
	„ W 49·554	}		

Then, taking the mean of the two groups of chronometer comparisons, we have :—

(31)		(43)
h. m. s.		h. m. s.
7 31 1·54	=	6 17 2·33

And on applying the chronometer corrections, we find that :—

	h. m. s.
Dr. Pechüle, with chronometer 31, makes the local sidereal time . . .	6 17 51·63
Mr. Gill „ 43 „ „	6 17 51·87
Or—	s.
Dr. Pechüle − Mr. Gill	= −0·24
Difference of longitude between the positions of the instruments	−0·03

Therefore, finally, the difference of personal equation is :—

	s.
Pechüle − Gill	= −0·27

Observations for the determination of difference of personal equation between Dr. Pechüle and Mr. Gill in receiving telegraphic signals by the relay. Dr. Pechüle used the E. C. chronometer, while Mr. Gill used chronometer 31, to record independent signals, given by Mr. Watt :—

1875, JANUARY 5.

Comparisons of Chronometers.

E. C.			(31)			E. C.			(31)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
15	21	8·0 *	16	28	15·0	15	48	37·5	16	55	40·0
15	24	7·0	16	31	13·5	15	51	43·0	16	58	45·0

Time by E. C. chronometer, Dr. Pechüle	Time by chronometer 31, Mr. Gill	Time by E. C. chronometer, Dr. Pechüle	Time by chronometer 31, Mr. Gill
h. m. s.	h. m. s.	h. m. s.	h. m. s.
15 0 11·7	16 7 22·3	15 4 54·3	16 12 3·9
36·0	46·8	5 8·8	18·6
47·8	58·4	18·0	27·7
59·5	8 10·0	41·8	51·4
1 9·8	20·1	57·9	13 7·4
19·5	30·0	6 6·7	16·2
27·3	37·7	16·9	26·7
36·1	46·6	24·7	34·4
44·9	55·0	30·9	40·5
53·0	9 3·0	7 18·0	14 27·3
2 1·8	12·1	23·8	33·2
20·9	31·1	46·5	55·7
36·5	46·6	53·5	15 2·8
3 5·0	10 15·0	8 7·7	17·0
21·6	31·7	22·0	31·3
31·7	41·8	33·0	42·0
38·5	48·4	53·0	16 2·2
46·5	56·6	9 0·0	9·0
55·4	11 5·1	20·5	29·8
4 3·0	13·0	40·5	49·8
10·0	19·9	48·6	57·6
16·9	26·8	55·7	17 4·7
24·5	34·1	10 4·9	13·9
29·9	40·0	13·9	22·9
35·5	45·6	21·6	30·6
41·5	51·3	29·7	38·7
15 4 48·5	16 11 58·2	16 10 44·6	16 17 53·4

Applying the relative rate of the chronometers obtained from the comparisons, we have for the times of observing the signals :—

Time by E. C.			Time by chronometer 31			(31)−E. C.		
h.	m.	s.	h.	m.	s.	h.	m.	s.
15	4	50·183	16	12	0·000	+1	7	9·817

But the interpolated difference between chronometers (from comparisons by coincident beats) is $+1^h\ 7^m\ 9^s{\cdot}658$.

Therefore the difference of personal equation in observing signals by relay is :—

Pechüle−Gill . . . . . $= -0^s{\cdot}159$

* 7ˢ·0 in original.

Observations for personal equation between Dr. Pechüle and Mr. Gill in recording the audible taps of a transmitting key (Dr. Pechüle used the E. C. chronometer; Mr. Gill used chronometer 31) :—

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Time by E. C. chronometer, Dr. Pechüle	Time by chronometer 31, Mr. Gill	Time by E. C. chronometer, Dr. Pechüle	Time by chronometer 31, Mr. Gill
h. m. s.	h. m. s.	h. m. s.	h. m. s.
15 12 32·3	16 19 40·8	15 14 49·0	16 21 57·0
38·9	47·2	53·9	22 2·0
49·3	57·8	15 0·0	7·9
13 1·7	20 10·0	11·7	19·7
10·8	19·0	16·9	24·9
16·8	25·0	23·5	31·7
25·8	34·0	29·5	37·6
39·8	48·0	41·0	49·0
46·4	54·5	46·6	54·7
14 7·8	21 16·0	53·0	23 0·5
17·0	25·1	58·4	6·2
24·4	32·6	16 4·9	12·8
31·9	40·0	10·0	17·9
37·0	45·0	15 16 37·5	16 23 45·2
15 14 42·6	16 21 50·6	... ...	... ...

Again applying the relative rates of the chronometers obtained from the comparisons, we have for the times of observing the taps :—

Time by E. C.	Time by chronometer 31	(31)−E. C.
h. m. s.	h. m. s.	h. m. s.
15 14 51·965	16 22 0·000	+1 7 8·035

But the interpolated difference between chronometers (from comparisons by coincident beats) is $+1^{h}\ 7^{m}\ 8^{s}\cdot021$.

Therefore the difference of personal equation :—

Pechüle−Gill (for 'Key') . . . . . $=-0^{s}\cdot014$

To which we may add the result just obtained :—

Pechüle−Gill (for 'Relay') . . . . . $=-0\cdot159$

As Dr. Pechüle remained at Belmont, it is evident that the first only of these equations affects the signals sent from Pamplemousses, while those from Belmont are influenced solely by the second equation. The effect on the longitude is therefore equal to half the algebraic sum of the quantities.

CHAPTER VIII.

DETERMINATION OF THE DIFFERENCE OF LONGITUDE BETWEEN MAURITIUS AND ADEN BY THE TRANSPORT OF CHRONOMETERS—HOMEWARD JOURNEY.

THE materials for finding the difference of longitude between Mauritius and Aden by the transport of chronometers on the homeward journey are much more complete and symmetrical than on the outward journey. Exclusive of previous comparisons, the rates of the chronometers can be deduced from satisfactory time determinations on December 25 and January 5 before the voyage, and immediately after it from observations at Aden on January 20 and January 31. It is believed that the means of these rates, duly corrected for temperature, afford very reliable values for the voyage.

The chronometers were satisfactorily established on board the 'Dupleix' by January 5, and on that night their corrections were found by signals sent from Belmont to the telegraph office at Port Louis, whence the time was carried on board. At Aden Mr. Gill obtained the time almost immediately after landing by altitudes taken with a small Repsold Universal Instrument belonging to the Dutch Expedition to Réunion (see Chapter XIII.) The remaining time observations at Aden were made in the vertical of a pole star with the Troughton and Simms' altazimuth.

The chronometers were treated in exactly the same manner as on the outward journey. The subsequent tables of comparisons cover the time during which the chronometers were tested both at Belmont and Aden. They are printed on the plan already adopted for the outward voyage, for details of which see page 45. To facilitate identification of the dates it may be useful to state that the epochs correspond roughly to Greenwich mean time. A strict adherence to Belmont astronomical dates would have been very inconvenient, as many of the comparisons were made about noon. Except in a few cases no attempt has been made to correct errors of 5^s or 10^s, however obvious.

COMPARISON OF CHRONOMETERS—HOMEWARD JOURNEY.

	Rotation No.	Correction to (36)	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.
			SECONDS OF COMPARED CHRONOMETER										
			Nov. 30	Dec. 1	Dec. 2	Dec. 3	Dec. 4	Dec. 5	Dec. 6	Dec. 7	Dec. 8	Dec. 9	Dec. 10
		h. m.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
I.	1	− 0 2	44·5	42·5	41·0	38·5	37·5	35·0	34·5	31·5	...	...	...
	2	+ 0 8	32·5	33·5	35·0	36·5	37·5	38·5	40·5	41·5	...	...	...
	3	+ 0 8	31·5	33·5	35·0	36·5	38·5	41·0	43·5	45·0	...	...	...
	4	+ 0 2	65·0	65·0	64·5	63·5	63·0	62·0	61·5	59·5	...	...	...
	7	+ 0 10	2·5	4·2	5·5	7·0	8·0	10·5	11·5	13·0	14·5	...	...
	8	0 0	22·0	22·0	21·5	21·0	20·5	20·0	20·0	20·0	...	...	...
	9	+ 0 2	14·5	15·2	15·5	16·0	16·0	17·0	17·0	19·0	...	...	...
	10	+ 0 6	25·0	25·8	26·5	28·0	29·0	30·0	31·0	32·0	33·25	...	...
	11	+ 0 14	19·0	21·5	25·0	28·5	32·5	37·5	40·0	44·5	...	...	...
II.	12	− 0 10	82·5	78·0	75·0	71·0	68·0	63·5	60·5	56·5	...	...	47·0
	13	− 0 8	73·5	71·2	69·5	67·5	65·5	63·0	61·5	59·5	...	...	54·0
	14	− 0 6	69·5	65·5	61·0	58·0	54·5	50·5	47·0	44·0	...	...	34·5
	15	− 0 7	45·5	44·0	41·5	39·5	37·0	35·0	33·5	31·0	...	...	26·5
	16	− 0 3	55·5	53·5	51·5	49·3	47·0	45·0	42·5	40·5	...	...	35·0
	17	+ 0 10	4·5	5·5	7·0	9·0	11·0	13·0	14·5	17·5	...	...	23·3
	18	+ 0 8	75·0	73·0	72·0	70·5	69·5	...	75·0	73·5	...	...	70·0
	19	− 0 9	73·0	70·5	66·5	63·5	59·0	61·0	58·0	55·0	...	...	45·0
	20	+ 0 11	20·5	22·5	26·3	31·0	34·5	39·5	43·5	47·0	...	...	61·5
III.	21	0 0	54·5	54·8	55·2	55·0	55·0	55·0	56·0	56·5	...	...	58·5
	22	− 0 1	51·0	53·5	44·5	41·5	37·0	33·3	30·0	26·5	...	...	14·5
	23	0 0	13·0	12·0	11·8	10·2	9·5	7·5	7·5	6·0	...	...	3·5
	24	+ 0 3	43·5	44·5	45·0	45·0	45·0	46·5	46·5	46·5	...	...	47·5
	25	0 0	2·5	3·2	4·0	4·5	5·5	7·0	8·5	9·0	...	...	14·0
	26	− 0 22	59·5	53·8	48·5	43·5	38·5	32·0	28·0	22·0	...	...	7·5
	27	− 0 20	61·5	57·0	53·5	48·5	44·0	39·0	35·0	30·5	...	...	18·0
	28	− 0 8	92·0	90·0	87·0	83·2	80·0	76·5	73·0	69·0	...	...	59·5
	29	− 0 12	53·0	49·5	46·5	35·0	39·0	34·5	31·5	27·0	...	...	16·5
IV.	30	− 0 1	10·0	15·2	20·2	25·0	30·5	36·0	41·0	46·0	...	...	62·0
	32	+ 0 29	41·5	39·5	37·0	34·8	32·5	29·5	29·0	25 0	...	...	19·0
	33	− 0 6	48·0	46·0	44·5	42·5	40·0	38·5	37·0	35·0	...	...	29·5
	34	− 0 14	68·5	65·8	62·5	59·5	56·0	52·5	50·0	47·0	...	...	38·0
	35	− 0 6	65·5	63·5	61·5	59·0	56·5	54·8	52·5	50·0	...	...	45·0
	37	− 0 5	36·0	34·5	34·0	32·5	31·0	30·0	29·0	27·0	26·0	...	25·0
	42	− 0 7	70·0	67·2	63·5	62·5	60·0	58·5	55·5	53·0	49·5	...	44·5
V.	31	− 0 8	...	...	...	...	58·5	...	51·5	49·0	45·0	...	40·5
	38	+ 0 13	25·5	26·5	27·5	28·0	29·0	30·5	31·0	32·5	...	...	36·5
	39	+ 0 22	24·5	29·5	36·2	39·5	46·5	48·0	58·0	64·5	...	...	85·0
	40	+ 0 2	51·5	53·0	54·8	55·5	56·5	57·5	60·0	59·5	...	...	66·0
VI.	44	− 0 10	43·5	42·0	40·0	38·0	35·5	33·0	31·5	29·5	46·0	...	41·0
	45	− 0 18	87·5	84·2	81·5	78·5	75·0	72·0	69·0	66·0	...	...	56·5
	46	+ 0 13	0·0	6·5	11·0	17·5	23·0	30·0	35·5	41·0	38·0	...	46·5
	47	+ 0 3	159·0	145·0	132·0	118·5	104·0	...	76·0	62·0	...	...	21·5
	48	+ 4 45	104·0	100·0	94·5	83·0	81·0	74·5	69·5	65·0	...	...	48·5
	49	+ 0 2	32·5	34·5	37·2	39·0	40·5	43·5	46·0	47·5	...	...	54·5
	50	− 0 10	17·5	16·5	14·5	12·5	10·5	...	6·5	5·0	...	...	0·0
	51	− 0 11	58·0	56·0	53·0	51·0	47·5	44·5	41·5	39·5	...	...	31·5
	52	− 0 27	73·5	70·2	67·0	62·5	59·0	61·5	56·5	51·5	...	...	36·0
			h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
Epoch by (36) for Case I.			19 20	19 22	18 22	18 11	17 58	22 5	18 55	17 52	23 20	...	...
II.			19 26	19 12	18 4	17 58	18 5	21 4	18 43	18 7	...	...	18 46
III.			19 38	19 43	18 31	18 17	18 16	22 16	19 8	18 2	...	...	18 27
IV.			19 44	19 20	18 38	18 22	18 21	21 45	19 0	18 0	23 20	...	18 35
V.			19 57	18 59	18 10	17 52	18 15	20 30	18 54	18 13	23 20	...	18 53
VI.			19 50	19 27	18 17	18 5	17 52	21 12	18 55	17 42	23 21	...	18 38

COMPARISON OF CHRONOMETERS—HOMEWARD JOURNEY—*continued.*

	Rotation No.	Correction to (36)	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
			SECONDS OF COMPARED CHRONOMETER											
			Dec. 11	Dec. 13	Dec. 14	Dec. 15	Dec. 16	Dec. 17	Dec. 18	Dec. 20	Dec. 21	Dec. 21	Dec. 21	Dec. 22
		h. m.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
I.	1	− 0 2	24·5	20·0	...	15·5	14·0	12·0	9·5	4·5	2·3	2·0	1·75	...
	2	+ 0 8	46·0	48·0	49·5	51·0	52·5	53·5	55·0	57·0	57·4	58·5	58·05	...
	3	+ 0 8	53·0	56·5	59·0	60·5	63·5	65·0	66·5	71·0	72·0	73·5	73·0	...
	4	+ 0 2	58·0	56·0	55·5	54·5	54·0	53·0	51·5	50·0	48·5	48·75	48·3	...
	7	+ 0 10	19·0	22·0	24·0	25·5	27·0	29·5	30·5	35·5	34·6	35·75	35·5	...
	8	0 0	18·0	18·0	16·5	17·0	17·0	16·5	16·5	15·5	14·5	15·5	14·6	...
	9	+ 0 2	20·5	20·5	21·0	22·0	22·5	23·0	23·5	24·0	23·6	24·5	24·0	...
	10	+ 0 6	35·0	37·0	37·0	38·5	40·0	40·0	40·0	41·5	41·4	41·75	41·6	...
	11	+ 0 15	1·0	9·0	12·5	17·5	22·0	25·5	29·5	38·0	40·3	42·5	42·0	...
II.	12	− 0 10	43·0	35·5	31·5	28·5	24·5	20·5	17·5	10·5	7·45	6·75	6·4	...
	13	− 0 8	51·5	47·5	45·0	43·0	42·0	39·5	37·5	32·5	30·6	30·25	30·0	...
	14	− 0 7	91·0	84·0	80·5	77·5	74·5	71·5	67·5	60·5	57·0	56·25	55·8	...
	15	− 0 7	25·0	22·0	21·0	19·5	18·5	17·0	16·0	12·5	11·0	11·0	10·5	...
	16	− 0 3	34·5	33·5	33·5	33·5	33·5	32·5	30·5	28·0	26·15	26·5	26·0	...
	17	+ 0 10	25·0	29·0	31·0	33·0	35·0	37·0	39·5	42·0	43·0	44·5	48·85	...
	18	+ 0 8	69·0	66·5	64·5	62·5	62·0	60·5	59·5	56·0	54·5	54·5	54·0	...
	19	− 0 9	41·5	34·5	31·5	28·5	25·0	21·5	17·5	10·0	7·4	6·5	6·25	...
	20	+ 0 12	6·0	14·0	18·5	23·0	28·0	32·5	36·0	45·0	48·0	50·5	50·0	...
III.	21	0 0	59·0	60·5	61·0	61·5	62·5	63·0	62·5	64·5	64·35	65·5	64·75	...
	22	− 0 2	70·0	61·0	56·0	51·0	46·5	41·5	37·0	27·5	23·8	22·5	22·25	...
	23	− 0 1	64·0	62·0	61·0	60·5	59·5	58·5	57·0	55·5	54·3	54·5	54·05	...
	24	+ 0 3	47·5	47·5	47·0	46·5	46·5	46·0	45·0	43·5	42·55	42·75	42·55	...
	25	0 0	14·5	17·0	18·0	20·5	22·0	23·5	24·5	28·0	28·3	29·5	29·1	...
	26	− 0 23	61·0	52·0	47·5	42·0	37·0	32·0	27·0	18·5	15·0	13·5	13·2	...
	27	− 0 21	72·5	61·5	57·0	51·5	47·0	41·5	36·0	24·0	19·75	18·5	17·8	...
	28	− 0 8	55·0	47·5	45·0	41·0	37·5	34·5	30·5	24·0	20·8	20·0	19·5	...
	29	− 0 13	73·0	65·0	61·5	57·5	54·0	51·0	46·5	39·0	36·0	35·0	34·5	...
IV.	30	0 0	7·5	16·5	21·5	27·0	32·5	38·5	43·5	53·5	56·2	58·75	58·6	...
	32	+ 0 28	76·5	71·5	69·5	66·5	65·1	62·5	60·0	55·5	53·3	53·0	52·5	...
	33	− 0 6	28·0	22·5	20·5	18·5	17·0	15·0	12·5	8·5	6·8	7·0	6·65	...
	34	− 0 14	34·5	28·5	25·5	22·5	19·0	16·0	13·5	8·0	5·55	5·25	4·6	...
	35	− 0 6	43·0	38·5	36·0	33·5	32·5	30·5	27·5	23·5	21·85	22·0	21·4	...
	37	− 0 5	...	21·5	19·5	18·5	17·0	15·0	14·5	11·0	9·7	10·5	9·6	...
	42	− 0 7	40·5	35·0	31·5	29·5	27·0	23·5	20·0	14·5	11·6	11·5	11·0	...
V.	31	− 0 9	97·0	...	96·5	82·5	77·25	76·0*	70·0	59·5	...	55·5	...	...
	38	+ 0 13	37·5	39·5	40·0	41·0	42·5	43·5	44·0	45·0	45·5	46·5	45·9	...
	39	+ 0 23	30·5	44·5	49 5	58·5	66·0	74·0	74·0	85·0	90·5	94·0	94·0	...
	40	+ 0 3	7·0	11·0	12·0	14·0	15·0	15·5	16·5	19·5	19·5	20·5	20·25	...
VI.	44	− 2 4	40·5	38·0	37·0	36·0	34·5	33·5	32·5	29·5	28·5	28·5	28·1	...
	45	− 0 18	53·0	45·5	42·5	39·0	35·5	32·0	29·0	21·5	18·25	17·25	17·05	...
	46	− 2 4	50·0	57·0	61·5	66·5	70·0	75·0	80·0	89·0	91·7	93·75	93·95	...
	47	− 1 0	188·5	161·0	147·5	134·5	120·5	109·0	94·5	107·0	57·3	53·5	52·5	...
	48	+ 4 44	102·5	89·5	82·5	76·0	69·5	62·5	55·0	41·0	35·8	34·0	33·1	...
	49	+ 0 2	57·0	62·0	63·5	67·0	70·0	71·5	73·5	78·0	78·95	80·25	80·35	...
	50	− 0 11	57·8	54·0	52·5	49·5	48·5	46·5	44·0	40·0	38·5	33·75	28·0	...
	51	− 0 12	85·0†	82·0	79·0	75·5	72·5	70·0	66·0	61·0	58·35	57·0	57·5	...
	52	− 0 27	91·5	81·5	75·0	71·0	66·0	61·0	55·5	45·5	41·0	40·0	39·25	...
			h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
Epoch by (36) for Case I.			18 33	18 11	17 53	18 32	19 30	17 40	17 58	17 24	10 6	18 31	19 31	...
	II.		18 52	18 17	18 2	19 0	19 54	18 4	18 14	17 13	10 40	19 15	20 5	...
	III.		18 47	17 55	17 28	18 51	19 47	17 56	18 8	17 55	10 31	18 55	19 57	...
	IV.		18 41	18 5	17 40	18 45	19 45	17 52	18 7	17 45	10 25	18 42	19 53	...
	V.		18 57	18 22	18 15	18 46	20 5	18 13	18 5	17 30	10 40	18 45	20 6	...
	VI.		18 30	18 5	17 42	18 30	19 28	17 35	17 55	17 35	10 30	18 25	19 46	...

* 46ˢ·0 in original.

† 105ˢ·0 in original.

COMPARISON OF CHRONOMETERS—HOMEWARD JOURNEY—*continued.*

	Rotation No.	Correction to (36)	XXIV.	XXV.	XXVI.	XXVII.	XXVIII.	XXIX.	XXX.	XXXI.	XXXII.	XXXIII.	XXXIV.	XXXV.
			SECONDS OF COMPARED CHRONOMETER											
			Dec. 23	Dec. 23	Dec. 24	Dec. 25	Dec. 26	Dec. 27	Dec. 28	Dec. 30	Dec. 31	Jan. 1	Jan. 2	Jan. 4
		h. m.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
I.	1	− 0 3	58·6	57·0	55·0	52·0	50·5	47·5	44·5	38·5	35·0	32·0	29·0	24·5
	2	+ 0 8	59·55	60·5	60·5	61·5	61·5	62·5	62·5	64·0	64·5	65·0	65·5	66·5
	3	+ 0 9	15·95	17·5	19·5	21·5	23·5	25·0	26·0	30·5	32·5	34·5	36·5	39·5
	4	+ 0 2	47·05	46·5	45·5	44·0	42·0	41·5	39·5	35·0	33·5	31·5	29·5	27·0
	7	+ 0 10	37·95	40·0	41·5	43·5	45·5	47·25	48·5	51·5	53·5	56·0	59·5	62·5
	8	0 0	13·2	13·0	12·0	11·0	10·0	9·5	8·0	5·0	4·0	3·0	2·0	0·5
	9	+ 0 2	24·6	25·0	25·5	25·5	25·0	25·5	25·0	25·0	24·5	24·5	24·5	24·5
	10	+ 0 6	42·6	43·0	42·5	42·5	43·0	43·5	43·5	44·5	45·0	45·5	44·0	47·0
	11	+ 0 15	47·55	50·0	52·5	56·0	60·0	63·75	67·0	76·0	80·5	84·0	89·0	94·0
II.	12	− 0 11	60·35	58·5	54·5	51·0	47·5	43·5	40·0	31·0	27·0	21·5	17·5	12·0
	13	− 0 9	86·9	85·0	82·0	79·75	77·0	75·0	72·0	64·5	61·0	57·0	54·0	50·5
	14	− 0 7	50·4	48·5	45·5	41·5	38·5	34·75	31·5	22·0	17·5	12·75	8·5	4·0
	15	− 0 8	67·45	66·5	64·5	63·0	61·0	58·25	56·0	50·5	48·0	45·0	42·5	40·0
	16	− 0 3	24·8	25·0	23·5	...	20·5	18·5	16·5	12·5	10·0	7·0	6·0	3·0
	17	+ 0 10	45·5	46·5	47·0	...	49·5	50·5	51·5	51·5	52·0	52·5	53·0	54·5
	18	+ 0 8	51·85	50·5	49·5	53·0	46·0	44·0	41·5	37·0	35·0	32·5	30·5	28·5
	19	− 0 10	62·0	60·5	56·5	52·5	49·5	45·5	41·5	33·5	28·5	24·0	20·5	15·5
	20	+ 0 12	55·5	58·5	62·5	67·0	71·0	75·5	79·0	88·0	92·5	97·0	101·0	107·0
III.	21	0 0	64·2	64·4	63·5	63·5	62·5	62·0	61·0	60·5	60·0	59·5	59·5	59·5
	22	− 0 3	76·3	74·0	69·5	64·5	60·5	55·5	49·5	38·0	32·5	26·5	21·5	14·5
	23	− 0 1	52·5	51·5	50·5	49·5	...	47·0	46·0	41·0	39·0	37·0	34·5	32·0
	24	+ 0 3	41·0	40·5	39·0	37·0	35·5	33·5	31·0	24·5	20·5	16·5	12·5	7·0
	25	0 0	31·5	33·0	34·5	36·0	37·0	39·0	39·5	42·0	44·0	45·0	46·0	47·5
	26	− 0 24	67·5	65·0	60·5	55·5	51·0	47·0	41·5	32·0	27·0	22·0	17·0	12·5
	27	− 0 23	129·0	126·0	119·5	113·0	107·0	100·0	93·5	75·0	65·5	57·0	47·5	36·5
	28	− 0 9	75·4	74·0	71·0	68·0	66·0	62·5	60·5	55·5	52·5	50·0	47·5	44·0
	29	− 0 14	89·1	87·5	83·5	79·0	76·0	72·0	67·5	59·0	54·5	50·0	45·0	39·5
IV.	30	+ 0 1	6·0	10·0	14·5	19·5	24·5	29·0	34·0	42·5	47·5	52·5	57·5	64·5
	32	+ 0 28	48·6	47·0	44·0	41·0	38·0	35·5	33·0	26·0	21·5	17·5	14·0	10·5
	33	− 0 7	64·6	64·0	62·5	60·0	58·0	55·75	54·5	49·25	47·0	45·0	43·0	40·5
	34	− 0 15	60·5	59·5	56·5	53·5	...	47·5	44·5	37·0	33·5	30·5	27·0	22·5
	35	− 0 7	78·3	77·5	74·5	72·0	...	67·0	64·5	59·0	56·0	53·0	50·5	47·5
	37	− 0 6	68·3	68·0	67·0	66·0	64·5	63·5	62·5	59·5	58·0	56·0	54·5	52·5
	42	− 0 8	67·1	66·0	62·5	59·5	56·5	53·75	50·5	45·0	41·5	38·5	36·0	32·5
V.	31	− 0 9	...	44·5	...	34·0	29·5	24·5	...	...	...	...	...	...
	38	+ 0 13	47·0	48·0	49·0	49·5	50·5	50·5	51·0	...	...	...	...	...
	39	+ 0 24	41·5	46·5	54·0	62·0	69·5	78·0	86·0	...	...	...	...	...
	40	+ 0 3	21·7	23·0	23·5	23·5	25·5	25·5	25·5	...	...	...	...	...
VI.	44	− 2 4	26·7	26·5	...	23·0	20·5	18·5	16·0	12·0	10·5	9·5	7·5	5·5
	45	− 0 19	72·0	70·5	66·5	61·5	...	54·0	50·0	40·5	35·0	31·5	27·5	22·0
	46	− 2 3	40·5	44·5	48·5	54·0	...	63·0	68·0	77·0	82·0	87·25	93·0	101·5
	47	− 1 3	213·6	206·0	192·0	177·0	164·5	151·0	137·0	105·5	91·0	75·5	61·5	40·5
	48	+ 4 42	142·5	138·5	131·5	123·0	116·0	107·0	101·0	82·0	72·5	63·5	55·0	46·5
	49	+ 0 3	23·6	25·5	27·0	29·0	31·0	33·0	34·5	39·0	41·5	43·0	45·0	47·0
	50	− 0 11	35·4	34·5	32·5	29·5	28·0	25·5	23·0	18·0	...	13·0	10·5	8·0
	51	− 0 12	53·5	52·0	49·0	45·0	42·0	38·5	35·0	29·0	25·0	22·0	18·5	14·5
	52	− 0 28	92·5	90·5	84·5	...	74·0	69·0	63·5	52·0	46·5	41·0	36·0	30·0
Epoch by (36) for Case I.			h. m. 4 34	h. m. 19 42	h. m. 19 8	h. m. 19 25	h. m. 18 36	h. m. 18 30	h. m. 17 20	h. m. 18 50	h. m. 19 22	h. m. 19 30	h. m. 18 33	h. m. 0 28
II.			5 18	19 30	18 56	19 50	18 22	18 10	17 54	18 34	19 6	19 17	18 16	1 23
III.			5 10	19 22	18 48	19 45	18 13	17 59	17 45	18 57	19 30	19 56	18 43	0 16
IV.			4 53	19 50	19 15	19 30	18 44	18 38	17 28	18 24	18 57	19 54	18 8	1 8
V.			4 53	19 21	19 0	20 5	18 18	18 13	17 59	...	...	...	...	...
VI.			5 0	19 25	18 43	19 37	18 12	17 57	17 34	18 40	19 14	19 27	18 23	0 42

COMPARISON OF CHRONOMETERS—HOMEWARD JOURNEY—*continued.*

	Rotation No.	Correction to (36)	XXXVI.	XXXVII.	XXXVIII.	XXXIX.	XL.	XLI.	XLII.	XLIII.	XLIV.	XLV.	XLVI.	XLVII.
			SECONDS OF COMPARED CHRONOMETER											
			Jan. 5	Jan. 7	Jan. 8	Jan. 9	Jan. 10	Jan. 11	Jan. 12	Jan. 13	Jan. 13	Jan. 14	Jan. 15	Jan. 16
		h. m.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
I.	1	− 0 4	81·0	75·7	73·1	71·3	69·15	67·0	64·7	63·55	62·55	60·65	59·05	56·7
	2	+ 0 9	6·6	7·35	8·6	9·4	9·9	10·1	10·55	10·55	11·1	11·65	12·25	12·6
	3	+ 0 9	41·8	46·65	50·6	53·35	56·5	59·25	62·2	63·65	65·05	67·6	70·25	72·7
	4	+ 0 2	24·5	20·0	18·35	16·8	15·0	13·35	11·65	10·6	9·8	8·4	7·2	5·7
	7	+ 0 11	4·1	8·2	12·0	14·1	16·2	18·5	21·2	22·35	23·6	25·65	28·05	30·1
	8	− 0 1	58·35	55·7	54·8	53·8	52·5	51·45	50·6	49·95	49·55	48·8	48·2	47·35
	9	+ 0 2	23·7	23·4	23·6	23·6	23·5	23·5	23·3	23·4	23·3	23·4	23·75	23·85
	10	+ 0 6	47·35	48·0	49·05	49·5	50·1	50·75	51·0	51·1	51·55	52·2	52·6	52·85
	11	+ 0 16	37·5	46·7	54·4	59·0	64·1	69·05	74·0	76·5	79·2	83·8	89·0	93·9
II.	12	− 0 12	66·95	58·25	53·0	49·4	45·5	41·5	37·2	...	33·35	29·8	26·3	22·5
	13	− 0 9	46·55	41·45	39·0	37·25	35·4	33·25	31·0	...	28·85	27·0	25·1	23·05
	14	− 0 8	59·5	52·2	48·1	45·5	42·5	34·4	35·7	...	32·6	29·0	25·5	22·1
	15	− 0 8	38·5	35·75	35·7	35·6	34·65	33·75	32·2	...	31·25	30·65	29·55	27·68
	16	− 0 4	60·0	55·35	52·6	50·6	48·8	47·5	45·35	...	43·3	41·6	39·7	37·85
	17	+ 0 10	54·5	55·5	57·6	58·4	58·95	59·9	60·2	...	60·7	61·7	62·5	62·75
	18	+ 0 8	25·2	23·6	23·55	23·2	22·7	22·1	21·65	...	21·2	20·95	20·8	20·5
	19	− 0 11	70·3	61·1	55·55	51·65	47·5	43·6	39·7	...	35·6	31·75	28·0	24·1
	20	+ 0 13	50·8	59·4	67·1	71·75	77·05	82·4	87·7	...	93·15	98·2	104·0	108·8
III.	21	0 0	58·35	58·5	58·55	58·05	57·6	58·5	58·2	...	58·25	58·0	58·4	58·45
	22	− 0 4	67·0	56·35	48·6	43·05	36·75	30·6	24·35	...	18·6	13·3	7·65	1·95
	23	− 0 1	29·7	27·55	26·45	25·35	23·75	21·75	19·85	...	18·65	17·5	16·4	14·85
	24	+ 0 2	62·5	57·0	54·5	51·8	47·6	43·05	38·75	...	34·8	32·05	29·6	27·15
	25	0 0	49·05	51·5	54·05	55·5	57·5	59·25	60·85	...	62·2	63·8	65·55	67·0
	26	− 0 25	67·0	57·2	50·5	44·25	39·55	35·0	30·2	...	25·5	21·55	17·15	12·5
	27	− 0 25	146·55	129·5	119·35	111·5	102·0	91·0	81·2	...	72·2	64·75	57·6	49·6
	28	− 0 9	40·3	32·25	27·4	24·1	21·0	18·6	15·7	...	12·8	9·95	7·0	3·6
	29	− 0 15	93·6	84·8	80·4	77·8	74·1	69·6	65·7	...	61·8	58·5	55·0	51·6
IV.	30	+ 0 2	10·45	25·1	37·45	44·55	52·05	59·05	66·1	...	73·65	80·55	88·2	95·4
	32	+ 0 27	66·3	58·5	53·75	50·6	47·55	43·55	40·1	...	36·7	33·6	30·8	27·6
	33	− 0 7	39·5	40·45	41·55	42·4	43·1	42·9	42·95	...	44·5	45·45	46·65	47·65
	34	− 0 16	78·0	69·6	64·45	61·5	58·1	55·15	51·7	...	48·05	44·8	41·3	37·6
	35	− 0 7	43·0	37·1	33·6	31·0	28·5	25·8	23·1	...	20·7	18·6	16·2	13·7
	37	− 0 6	50·95	48·5	47·3	46·6	45·55	44·5	43·25	...	42·55	41·8	41·2	40·3
	42	− 0 9	88·55	82·5	78·8	76·4	73·8	71·0	67·9	...	65·3	63·0	60·2	57·55
V.	31	− 0 11	...	87·1	78·2	72·3	67·1	60·8	54·9	...	49·5	44·0	38·55	32·6
	38	+ 0 13	...	56·5	59·2	60·5	61·75	62·95	64·2	...	65·7	67·2	68·95	70·2
	39	+ 0 26	...	33·15	43·3	50·6	56·5	63·8	70·7	...	77·9	85·55	92·55	100·15
	40	+ 0 3	...	34·2	37·5	38·8	40·2	41·2	42·4	...	43·5	45·1	47·0	48·5
VI.	44	− 2 5	62·5	58·0	55·25	53·65	52·0	50·5	48·6	...	47·0	45·6	44·0	42·7
	45	− 0 20	76·8	68·9	64·3	60·6	57·0	53·4	50·0	...	46·75	43·7	40·3	37·0
	46	− 2 2	50·7	65·5	77·45	82·8	89·55	96·25	102·4	...	107·85	113·5	119·85	125·6
	47	− 1 6	200·5	168·5	146·3	132·1	116·6	101·3	85·7	...	70·5	56·45	41·05	25·85
	48	+ 4 41	96·05	84·45	76·75	71·6	65·15	58·45	51·45	...	44·15	37·6	31·5	24·9
	49	+ 0 3	48·3	50·65	53·5	55·0	56·5	58·0	59·45	...	60·7	62·2	63·75	65·35
	50	− 0 12	65·0	59·8	56·9	54·55	52·35	50·0	47·4	...	45·25	43·3	41·35	39·15
	51	− 0 13	69·0	59·5	58·4	49·3	45·35	41·0	36·9	...	33·7	30·6	26·6	22·8
	52	− 0 29	83·8	74·55	68·25	64·0	59·6	55·4	50·9	...	46·6	42·75	38·5	33·9
			h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h m.	h. m.
Epoch by (36) for Case	I.		3 40	7 5	20 28	19 40	20 12	20 7	20 38	8 22	21 5	19 34	19 35	19 49
	II.		3 55	7 10	20 39	19 50	20 21	20 16	20 48	...	21 13	19 42	19 53	20 5
	III.		4 3	7 17	20 47	20 1	20 32	20 44	21 2	...	21 23	19 51	20 3	20 15
	IV.		4 10	7 25	21 13	20 23	20 53	21 4	21 27	...	21 41	20 9	20 12	20 29
	V.		...	7 25	21 18	20 24	20 55	21 6	21 29	...	21 43	20 10	20 20	20 36
	VI.		4 17	7 40	21 42	20 34	21 6	21 15	21 40	...	21 51	20 19	20 29	20 47

COMPARISON OF CHRONOMETERS—HOMEWARD JOURNEY—*continued.*

	Rotation No.	Correction to (36)	XLVIII.	XLIX.	L.	LI.	LII.	LIII.	LIV.	LV.	LVI.	LVII.	LVIII.	LIX.
			Seconds of Compared Chronometer											
			Jan. 17	Jan. 18	Jan. 19	Jan. 20	Jan. 20	Jan. 21	Jan. 22	Jan. 24	Jan. 25	Jan. 26	Jan. 27	Jan. 28
		h. m.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
I.	1	− 0 4	54·6	52·55	50·0	48·9	47·75	46·0	44·45	41·45	40·6	38·5	37·05	36·0
	2	+ 0 9	13·0	13·45	13·7	14·0	14·45	15·2	15·8	18·45	18·75	20·35	21·55	21·75
	3	+ 0 10	15·35	17·85	20·5	21·6	23·1	25·6	27·5	33·15	34·6	38·8	41·6	43·05
	4	+ 0 1	64·3	62·7	61·1	60·25	59·4	58·0	57·1	55·5	55·0	53·8	52·6	52·0
	7	+ 0 11	32·1	34·05	36·85	38·0	39·6	42·0	44·1	49·2	50·55	53·8	56·25	57·75
	8	− 0 1	46·45	45·6	45·0	44·6	44·4	44·1	43·7	43·8	43·6	43·6	43·8	43·6
	9	+ 0 2	23·85	23·8	23·8	23·8	23·9	24·3	24·85	27·15	27·95	29·0	30·1	30·7
	10	+ 0 6	52·85	53·2	53·35	53·6	54·05	54·8	55·2	58·15	59·1	61·75	63·75	64·5
	11	+ 0 17	38·65	43·8	49·1	51·5	54·55	60·0	64·1	76·4	79·5	87·5	93·15	95·9
II.	12	− 0 13	78·5	74·8	71·0	69·3	67·4	64·05	61·5	55·2	53·6	49·6	46·6	45·0
	13	− 0 9	20·95	18·75	16·55	15·5	14·4	12·6	11·0	8·3	7·5	5·5	4·2	3·5
	14	− 0 9	79·05	75·75	72·05	70·6	68·85	66·45	64·5	59·45	58·05	55·0	52·55	51·5
	15	− 0 8	25·45	23·5	22·35	21·2	20·35	19·65	18·9	18·35	17·75	17·3	16·65	16·2
	16	− 0 4	36·6	34·75	32·8	31·0	30·3	28·75	26·6	21·95	20·6	17·55	15·35	14·1
	17	+ 0 11	3·45	4·0	4·6	4·55	4·8	6·1	7·35	11·25	12·15	14·6	16·75	17·5
	18	+ 0 8	19·8	19·3	18·7	18·2	18·15	17·9	17·6	18·5	18·5	18·8	18·75	18·5
	19	− 0 12	80·0	75·85	71·55	69·65	67·6	63·5	60·15	52·5	50·55	45·4	41·55	39·55
	20	+ 0 14	54·3	59·7	65·0	67·3	70·6	76·4	81·2	94·0	97·2	106·0	111·6	114·75
III.	21	0 0	58·7	59·3	59·7	60·0	60·9	61·0	61·4	63·0	63·5	65·55	66·45	67·0
	22	− 0 5	56·05	50·35	44·4	41·6	38·5	33·4	29·4	20·6	18·5	13·55	9·5	7·6
	23	− 0 1	13·3	11·9	10·5	9·55	8·6	8·5	8·4	8·8	9·0	10·0	10·1	10·55
	24	+ 0 2	24·55	22·5	20·0	18·8	17·6	16·85	16·5	17·5	18·0	19·15	20·0	20·8
	25	+ 0 1	8·5	9·8	11·15	11·75	12·65	14·2	15·4	18·8	19·6	22·05	23·5	24·2
	26	− 0 26	68·0	63·5	58·6	56·5	53·85	49·8	46·8	39·5	37·6	32·55	28·25	26·5
	27	− 0 26	101·5	94·05	86·4	82·5	78·5	72·7	68·25	59·4	57·1	52·0	48·1	45·6
	28	− 0 10	60·6	57·65	54·7	53·0	51·05	48·45	46·1	41·45	40·0	36·3	33·0	31·25
	29	− 0 15	48·1	44·9	41·1	39·05	37·3	35·25	33·0	28·0	26·6	23·5	20·5	19·1
IV.	30	+ 0 3	42·7	50·25	57·75	61·1	65·6	73·5	79·75	97·05	101·65	113·2	121·5	125·7
	32	+ 0 26	84·0	80·5	77·0	75·6	73·65	71·1	69·15	64·5	63·55	59·85	57·25	56·2
	33	− 0 7	48·7	50·05	51·05	51·45	52·55	54·55	56·5	62·6	65·05	70·05	73·45	75·55
	34	− 0 17	93·6	89·8	85·95	84·1	82·15	78·65	75·7	69·15	67·15	62·0	58·55	57·15
	35	− 0 8	71·3	68·65	66·35	65·2	63·75	61·65	59·9	54·35	53·15	50·45	48·1	47·2
	37	− 0 6	39·6	39·0	38·3	38·05	37·65	37·1	36·3	35·55	35·25	35·4	35·15	35·15
	42	− 0 9	54·5	51·4	48·3	47·0	45·5	42·8	40·9	36·6	35·15	32·0	29·5	28·15
V.	31	− 0 12	86·7	81·55	75·5	72·6	69·4	64·0	59·8	54·5	46·7	40·0	35·0	32·25
	38	+ 0 14	11·5	12·6	13·9	14·5	15·25	17·1	18·5	22·8	24·0	26·8	28·6	29·75
	39	+ 0 27	46·2	53·2	61·1	64·45	69·15	77·75	82·85	96·1	100·0	108·0	115·0	118·55
	40	+ 0 3	50·1	51·5	53·6	54·1	55·25	57·8	59·0	63·5	64·7	67·85	69·8	70·65
VI.	44	− 2 5	40·95	39·55	38·0	37·5	37·05	36·35	36·0	36·05	36·1	36·45	36·55	36·6
	45	− 0 20	33·7	31·0	28·0	26·4	24·1	21·35	19·1	13·6	12·05	8·5	5·8	4·1
	46	− 2 0	11·4	17·1	22·75	25·0	28·95	35·95	41·0	55·0	58·2	67·55	73·5	76·5
	47	− 1 9	190·6	175·1	159·85	152·5	143·15	128·35	116·0	86·6	79·0	59·5	45·3	37·6
	48	+ 4 40	77·6	71·05	63·9	60·0	54·6	49·35	44·35	33·3	30·05	23·75	17·0	13·7
	49	+ 0 4	6·7	8·5	10·0	10·6	11·6	13·6	15·0	19·5	20·6	24·05	26·45	27·4
	50	− 0 12	36·9	35·0	32·75	31·6	30·55	28·9	27·3	25·0	24·45	22·9	21·5	20·95
	51	− 0 14	79·55	75·7	72·2	70·6	68·6	66·0	63·6	57·0	55·5	51·0	48·0	46·35
	52	− 0 30	89·6	85·5	81·1	79·1	76·7	72·6	69·5	62·3	60·5	56·0	52·5	50·6
			h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
Epoch by (36) for Case	I.		19 40	20 19	20 55	7 39	21 43	22 15	17 59	21 11	10 20	20 31	21 16	9 46
	II.		19 48	20 28	21 3	7 49	21 53	22 40	18 11	21 23	10 27	20 41	...	10 6
	III.		20 2	20 42	21 11	7 59	22 4	22 54	18 23	21 36	10 37	20 54	21 42	10 15
	IV.		20 14	20 50	21 21	8 7	22 17	23 8	18 36	21 46	10 46	21 6	21 51	10 25
	V.		20 21	20 58	21 32	8 13	22 20	23 26	18 50	21 55	10 52	21 16	22 0	10 31
	VI.		20 40	21 6	21 40	8 22	22 41	23 31	19 2	22 6	11 2	21 25	22 9	10 41

COMPARISON OF CHRONOMETERS—HOMEWARD JOURNEY—*continued.*

	Rotation No.	Correction to (36)	LX.	LXI.	LXII.	LXIII.	LXIV.	LXV.	LXVI.	LXVII.	LXVIII.	LXIX.	LXX.	LXXI.
			SECONDS OF COMPARED CHRONOMETER											
			Jan. 29	Jan. 30	Jan. 31	Jan. 31	Feb. 1	Feb. 2	Feb. 3	Feb. 4	Feb. 5	Feb. 6	Feb. 8	Feb. 9
		h. m.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
I.	1	− 0 4	34·0	32·45	31·05	30·8	28·4	25·75	23·05	20·1	18·4	16·75	15·5	15·5
	2	+ 0 9	22·8	23·6	24·0	23·1	25·0	24·75	24·95	25·6	25·8	26·8	28·1	29·8
	3	+ 0 10	46·6	49·6	51·5	52·0	55·1	57·85	60·4	63·4	66·1	69·4	73·5	77·8
	4	+ 0 1	50·45	49·1	48·0	47·6	46·0	44·2	42·5	40·3	39·05	38·1	37·5	37·85
	7	+ 0 12	0·6	2·9	4·15	4·6	6·9	8·6	10·0	10·5	13·4	15·6	18·6	22·1
	8	− 0 1	43·5	43·3	43·05	43·1	42·6	41·8	40·65	39·4	38·8	39·0	39·8	41·2
	9	+ 0 2	31·6	32·5	33·0	33·1	33·7	34·05	34·1	34·1	34·8	35·85	37·6	40·4
	10	+ 0 7	6·4	8·0	9·05	9·6	10·8	12·0	13·1	14·1	15·6	17·6	20·1	24·35
	11	+ 0 18	47·6	48·5	52·5	53·5	59·6	64·45	69·3	74·5	79·6	85·6	92·7	99·5
II.	12	− 0 13	41·25	38·3	35·6	35·0	31·4	26·95	23·0	18·5	15·4	12·15	9·1	7·25
	13	− 0 10	61·75	60·55	59·5	59·4	57·5	55·5	53·6	51·5	50·1	49·1	48·0	47·95
	14	− 0 9	48·55	46·6	44·5	43·8	41·0	38·0	34·6	30·9	28·3	25·9	23 05	23·0
	15	− 0 8	15·65	15·05	14·2	13·9	12·4	10·8	8·95	7·5	5·75	4·5	3·75	3·5
	16	− 0 5	71·95	70·0	68·15	67·8	64·9	62·75	61·5	59·4	58·1	56·65	54·6	55·0
	17	+ 0 11	19·6	21·5	22·3	22·6	24·1	24·8	25·6	26·4	27·75	30·0	32·6	36·4
	18	+ 0 8	18·5	18·5	18·15	18·2	17·6	17·0	16·4	15·5	15·1	15·05	15·5	15·1
	19	− 0 13	94·5	90·85	88·0	87·4	82·4	78·3	74·1	69·6	66·0	62·0	58·1	56·0
	20	+ 0 16	2·05	8·6	13·0	14·4	21·7	27·5	33·1	38·3	44·0	50·35	57·6	63·1
III.	21	+ 0 1	8·8	10·0	10·5	10·8	12·3	13·0	13·5	13·7	15·0	17·05	19·05	20·8
	22	− 0 6	62·55	58·5	55·5	54·6	48·8	43·5	38·1	32·0	27·8	24·0	20·4	19·1
	23	− 0 1	10·8	10·8	10·65	10·8	10·7	9·65	8·6	6·8	6·15	6·5	6·6	6·1
	24	+ 0 2	20·75	21·7	22·0	21·9	22·4	21·85	21·0	18·5	18·5	19·75	21·1	24·4
	25	+ 0 1	26·15	27·55	28·55	29·0	30·6	32·0	33·4	34·9	36·5	38·05	40·0	46·6
	26	− 0 27	81·1	76·55	73·8	73·0	67·6	62·95	57·95	52·5	48·2	44·05	40·05	39·3
	27	− 0 27	100·0	95·65	92·6	91·8	86·5	80·5	74·5	66·5	61·6	57·5	53·85	53·5
	28	− 0 11	87·15	83·1	80·6	80·0	75·4	71·25	67·15	62·9	59·05	55·5	51·5	51·6
	29	− 0 16	75·55	72·55	70·15	69·6	65·9	61·9	57·8	53·5	51·0	49·1	47·6	49·1
IV.	30	+ 0 5	15·55	23·8	29·5	31·0	40·3	47·05	54·2	61·4	68·8	77·55	86·95	95·65
	32	+ 0 26	52·8	50·3	48·55	47·8	44·4	40·75	37·05	33·2	30·5	27·6	25·1	25·5
	33	− 0 6	18·7	20·35	21·05	21·0	22·1	22·75	23·5	23·5	24·95	27·0	29·0	30·5
	34	− 0 17	52·85	49·6	47·2	46·6	42·5	38·9	34·95	31·0	27·75	23·85	19·65	16·7
	35	− 0 8	44·5	42·6	...	40·8	38·5	36·1	33·6	31·0	28·85	26·6	24·5	23·1
	37	− 0 6	35·0	35·1	35·1	35·1	35·1	35·0	34·65	34·5	34·95	35·5	36·1	36·65
	42	− 0 10	84·85	82·2	80·1	79·6	76·0	73·1	70·25	67·1	65·0	62·65	60·35	59·5
V.	31	− 0 13	91·6	80·1	76·3	75·4	68·6	62·5	56·5	49·9	44·9	40·4	35·5	33·85
	38	+ 0 14	31·6	33·5	34·8	35·0	36·6	37·5	38·5	39·5	41·6	44·25	47·2	50·5
	39	+ 0 29	6·05	13·1	18·1	19·3	26·3	33·5	41·4	49·1	57·0	65·2	74·0	83·2
	40	+ 0 4	13·0	14·8	15·8	16·0	18·1	19·5	20·75	22·0	24·15	26·6	29·7	33·4
VI.	44	− 2 5	36 5	36·15	36·0	35·8	35·1	34·05	33·5	33·0	32·55	32·45	32·1	32·5
	45	− 0 21	60·65	57·35	55·0	54·5	51·0	47·0	43·45	39·6	36·6	34·0	31·1	29·6
	46	− 1 59	23·8	29·9	33·75	34·8	41·7	46·55	51·35	56·0	61·5	68·1	75 6	83·0
	47	− 1 12	200·2	185·75	175·0	172·5	155·5	140·7	126·15	110·0	95·85	81·05	65·5	53·95
	48	+ 4 39	67·25	60·9	56·6	55·5	47·5	41·6	35·5	27·0	21·0	14·8	9·15	9·05
	49	+ 0 4	29·75	31·95	33·1	33·6	36·0	37·55	39·15	40·9	42·8	45·4	48 3	51·0
	50	− 0 12	19·15	18·0	16·8	16·5	14·5	12·55	10·6	8·5	7·3	6·45	5·65	5·6
	51	− 0 14	42·0	38·65	36·1	35·5	31·4	26·55	21·75	17·3	13·6	10·5	7·0	4·4
	52	− 0 30	46·1	42·5	39·6	39·0	34·5	30·4	26·15	21·65	18·1	14·6	11·0	8·4
Epoch by (36) for Case I.			h. m. 16 1	h. m. 17 1	h. m. 11 15	h. m. 15 50	h. m. 20 40	h. m. 20 33	h. m. 20 29	h. m. 20 58	h. m. 20 52	h. m. 23 2	h. m. 4 11	h. m. 4 15
II.			16 11	17 8	11 21	15 55	20 45	20 43	20 39	21 7	21 3	23 15	3 51	3 50
III.			16 23	17 18	11 28	16 5	20 58	20 54	20 51	21 22	21 15	23 24	...	4 58
IV.			16 34	17 31	11 35	16 12	21 12	21 4	21 0	21 38	21 27	23 33	3 21	4 24
V.			16 45	17 40	11 41	16 17	21 22	21 20	21 7	21 56	21 39	23 42	4 16	3 40
VI.			16 52	17 47	11 47	16 27	21 34	21 32	21 40	22 9	21 52	23 51	4 5	4 7

Operations at Belmont.

Comparisons of Chronometers.

1874, December 25.

(31)	(36)
h. m. s.	h. m. s.
20 14 34·0	20 23 0·0

1874, December 26.

(31)	(36)
h. m. s.	h. m. s.
17 42 29·5	17 51 0·0

1875, January 5.

(36)	(43)	(31)	(39)
h. m. s.	h. m. s.	h. m. s.	h. m. s.
4 55 43·0	3 35 50·5	6 7 0·0	6 42 39·5
		6 19 0·0	6 54 40·1

(31)	(40)	(31)	(38)
h. m. s.	h. m. s.	h. m. s.	h. m. s.
6 9 0·0	6 21 53·8	6 10 0·0	6 33 17·2
6 19 0·0	6 31 53·7	6 18 0·0	6 41 17·2

Time Determinations.

The time determinations on p. 126 *et seq.* supply the following corrections of the chronometers 43 and 31 on December 25, 26, and 27 :—

Chronometer 43 (*sidereal*).

Date	Epoch by chronometer 43	Correction of chronometer 43 to local sidereal time
	h. m.	s.
1874, Dec. 25	5 23·2	+ 9·70
„ „ 26	2 36·1	+ 13·155

And on converting the corrections of (31) from sidereal to mean time :—

Chronometer 31 (*mean time*).

Date	Epoch by chronometer 31	Correction of chronometer 31 to local mean time	*Hourly* rate
	h. m.	h. m. s.	s.
1874, Dec. 25	9 7·3	+ 3 50 27·75	
			+ 0·0982
„ „ 26	4 59·1	29·70	
			+ 0·0864
„ „ 27	6 29·2	31·90	

To find the rates of the chronometers Dr. Pechüle also made the subjoined observations with Dr. Löw's transit instrument and chronometer 31 :—

1875, JANUARY 5

Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of transit over wire VI.			Level readings	
		I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.					
		s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
a Argûs	E	23·2	3·6	...	43·7	...	23·8	...	4·3	...	44·2	24·2	7	30	23·81	+ 10·8	− 11·2
																+ 14·3	− 7·8
ϵ Gemin.	„	2·7	49·4	...	36·0	...	22·7	...	9·4	...	56·1	42·7	7	45	22·69	+ 13·3	− 9·2
																+ 11·1	− 11·3
a Can. maj.	„	24·4	11·5	...	59·4	...	46·6	...	34·3	...	21·3	9·0	7	48	46·62	+ 11·4	− 11·0
																+ 14·3	− 8·1
ζ Mensæ	„	...	...	..	...	...	...	52·5	29·2	...	...	59·2	7	59	42·49	+ 15·2	− 7·2
																+ 11·3	− 11·3
„	W	...	...	...	...	...	...	38·0	2·1	27·7	17·2	31·7			48·51	+ 14·2	− 8·5
																+ 8·7	− 14·1
C Puppis	„	...	40·1	...	56·3	...	12·7	...	28·7	...	45·1	1·5	8	9	12·63	+ 8·4	− 14·3
																+ 12·4	− 10·3
51 Gemin.	„	38·6	51·1	...	3·3	...	16·1	...	28·4	...	41·2	54·1	8	15	16·14	+ 12·4	− 10·3
																+ 10·4	− 12·2
π Argûs	„	3·5	18·7	...	33·7	...	48·8	...	3·7	...	18·8	33·7	8	21	48·73	+ 10·2	− 12·6
																+ 13·0	− 9·8

Reducing these, we have :—

Level		Collimation,	Azimuth
E	W	Circle W	
s.	s.	s.	s.
+0·094	+0·060	−0·480	+1·182

Epoch by chronometer and assumed *hourly* chronometer rate	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Chronometer rate to epoch	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
h. m. s.			h. m. s.	s.	s.	h. m. s.	h. m. s.
7 59 0	*a* Argûs	E	7 30 23·81	−4·75	−0·13	6 21 12·65	−1 9 6·28
s.							
+9·956	ϵ Geminorum	„	7 45 22·69	−2·26	+1·53	6 36 15·63	6·33
	a Canis maj.	„	7 48 46·62	−1·70	+0·68	6 39 39·41	6·19
	ζ Mensæ	„	7 59 42·49	+0·12	−3·12	6 50 33·13	[6·37]
	„	W	48·51	+0·13	−9·14	„	
	C Puppis	„	8 9 12·63	+1·70	−1·17	7 0 6·61	6·55
	51 Geminorum	„	8 15 16·14	+2·70	+0·28	7 6 12·73	6·39
	π Argûs	„	8 21 48·73	+3·79	−0·96	7 12 45·08	6·48

And then, by taking the means :—

Epoch by chronometer 31

h. m. s.

7 59 0

Chronometer correction to local sidereal time

	h. m. s.		h. m. s.
Circle E	−1 9 6·267	−1 9 6·37	
„ W	6·473		

Time Determinations at Belmont.

From the comparisons of chronometers 36 and 31 and the corrections and rates of the latter we have for (36) :—

Date	Epoch by chronometer 36	Correction of chronometer 36 to local mean time	*Hourly* rate
	h. m.	h. m. s.	s.
1874, Dec. 25	20 23·0	+3 42 2·84	−0·1183
„ „ 26	17 51·0	0·30	

To obtain the errors on Belmont time of the chronometers on board the steamer they were compared with chronometer 36, the corrections of which were found by telegraphic signals interchanged between Port Louis and the observatory at Belmont. To introduce the method of coincident beats, the time at Belmont was taken by Dr. Pechüle from the beats of the electric contact chronometer, for which the corrections were determined chronographically by Dr. Copeland on January 5. It thus became necessary to find the personal equation between Drs. Pechüle and Copeland, and also the exact relations between the blows of the chronograph pricker and the beats of the electric contact chronometer. To deduce these relations, we have from the actual time determinations :—

Electric contact sidereal chronometer E. C. : Dr. Copeland.

Date	Epoch by E. C. chronometer	Correction of E. C. chronometer to local sidereal time	*Hourly* rate
	h. m.	s.	s.
1875, Jan. 5	5 4	−35·41	+0·034

Mean-time chronometer 31 *: Dr. Pechüle.*

Date	Epoch by chronometer 31	Correction of chronometer 31 to local sidereal time	*Hourly* rate
	h. m.	h. m. s.	s.
1875, Jan. 5	7 59	−1 9 6·37	+9·956

Dr. Pechüle then noted the coincidences of chronometer 31 and the beat of the chronograph pricker, which may be called the 'electric beat' to distinguish it from the actual beat of the chronograph chronometer, which will be termed the 'escapement beat' :—

E. C. 'electric beat'	(31)
h. m. s.	h. m. s.
5 50 15·0	6 58 56·0
7 30 46·0	8 39 10·5

Applying the corrections of the two chronometers given above to the mean of these comparisons, we have :—

	h. m. s.
Sidereal time by Dr. Copeland, using E. C. chronometer and chronograph . .	6 39 55·15
„ Dr. Pechüle, using chronometer 31	55·23

Therefore—

	s.
Pechüle − Copeland (chronograph)	= +0·08

To ascertain the difference between the 'electric beat' and the 'escapement beat' of the E. C. chronometer, the subjoined comparisons were made by Dr. Pechüle :—

E. C. 'escapement beat'	(31)
h. m. s.	h. m. s.
4 34 27·0	5 43 20·5
4 39 58·0	5 48 50·5
4 43 8·0	5 52 0·0

E. C. 'electric beat'	(31)
h. m. s.	h. m. s.
4 43 38·0	5 52 30·0
4 46 41·0	5 55 32·5
4 49 44·0	5 58 35·0

Taking the means and using the above rates, we have :—

	h.	m.	s.
(31) – 'Escapement beat'	= 1	8	51·43
(31) – 'Electric beat'	= 1	8	51·50

Whence we see that the 'electric beat' takes place $0^s{\cdot}07$ later than the 'escapement beat' of the E. C. chronometer.

Applying this correction, Dr. Copeland's time determination becomes :—

h. m.		s.	*Hourly* rate s.
At 5 4·0	by E. C. chronometer, correction of 'escapement beat' of E. C. chronometer to local sidereal time	−35·48	+0·034

The greater part of the chronometers having been conveyed on board the S.S. 'Dupleix' in readiness for the departure for Aden, signals were exchanged between Dr. Pechüle at Belmont and Mr. Gill at Port Louis. These signals were sent from one end at intervals of 10^s by the beat of the chronometer, while the coincidences between the relay and the chronometer were noted at the other end. As already stated, Dr. Pechüle used the E. C. sidereal chronometer at Belmont; Mr. Gill used the mean-time chronometer 36 at Port Louis.

Signals sent from Belmont and recorded at Port Louis.

	E. C. 'escapement beat'	(36)
	h. m. s.	h. m. s.
I.	3 48 18·0	5 6 40·0

Signals sent from Port Louis and recorded at Belmont.

	(36)	E. C. 'escapement beat'
	h. m. s.	h. m. s.
II.	5 12 41·0	3 54 20·0

Signals were then given at short intervals by an independent operator, the tap of the key being noted at the sending station and the beat of the relay at the other station.

Signals sent from Belmont to Port Louis and recorded at both stations (mean of 16 signals) :—*

	E. C. 'escapement beat'	(36)
	h. m. s.	h. m. s.
III.	4 3 15·94	5 21 35·48

Signals sent from Port Louis to Belmont and recorded at both stations (mean of 12 signals) :—*

	(36)	E. C. 'escapement beat'
	h. m. s.	h. m. s.
IV.	5 25 35·49	4 7 16·61

Whence, with the correction and rate of E. C. chronometer, we obtain as corrections of chronometer 36 to local (Belmont) mean time :—

	h.	m.		h.	m.	s.	
I. . .	At 5	6·7	by (36), correction of (36)	+3	41	32·32,	by coincidences, Belmont sending.
II. . .	„ 5	12·7	„ „			32·33,	„ Port Louis sending.
III. . .	„ 5	21·4	„ „			32·34,	independent signals, Belmont sending.
IV. . .	„ 5	24·7	„ „			32·34,	„ Port Louis sending.

* It has been considered unnecessary to give the individual signals.

From which, after adding the following corrections for personal equation (p. 154) and rate—

		Reduced to Gill		Mean of P. and G.		
		s.		s.		s.
I.	Personal equation	+0·014	or	+0·007	Rate	+0·02
II.	„	+0·000	or	+0·007	„	0·03
III.	„	+0·014	or	+0·086	„	0·05
IV.	„	+0·159	or	+0·086	„	0·06

we have :—

		h.	m	s.
At 4 55·7 by chronometer 36, correction of (36) to Belmont mean time by coincidence signals	.	+3	41	32·36
„ „ „ „ „ independent „	.			32·48

and double current time +0ˢ·02 and 0ˢ·01 respectively.

Therefore :—

	h.	m.	s.
At 4 55·7 by chronometer 36, correction of chronometer to Belmont mean time	+3	41	32·42

As a check upon the rate of chronometer 36 it was compared with chronometer 43 before and after the general comparison with all the chronometers as follows (chronometer 43 remaining at the telegraph office during the interval) :—

	(36)			(43) sidereal		
	h.	m.	s.	h.	m.	s.
Before general comparison . . .	2	28	37·0	1	8	21·0
After „ „ . . .	4	55	43·0	3	35	50·5

Now the *daily* rates of chronometers 36 and 43 were respectively −2ˢ·70 and +3ˢ·90, whence the interval in mean time between the comparisons is :—

	h.	m.	s.
By (36)	2	27	5·73
„ (43)	2	27	5·74

The close agreement of these intervals shows that the chronometer 36 neither tripped nor changed its rate during the transport of time on board the 'Dupleix,' and the given value +3ʰ 41ᵐ 32ˢ·42 must therefore be considered as the undisturbed correction of the chronometer.

The result is, however, for Dr. Copeland's method of observing with the 'escapement beat' of the E. C. chronometer ; but as Mr. Gill will henceforth be the observer, it has still to be corrected for their relative personal equation, which is assumed to be :—

	s.
Gill − Copeland	= +0·35*

Therefore, finally :—

	h.	m.		h.	m.	s.	Daily rate s.
1875, Jan. 5, at	4	55·7	by chronometer 36, correction of chronometer 36 to Belmont mean time	+3	41	32·77†	−2·70

The comparisons under date 1875, January 5, on p. 159 with (36) then define the errors of all the chronometers on Belmont time referred to Mr. Gill with the exception of four. Three of these, (38), (39), and (40), had been compared with (31)—the chronometer used by Dr. Pechüle for his time observations at Belmont. Allowing then for the personal equations between

* Obtained from Pechüle − Copeland . . . . . = +0ˢ·08 (p. 164).
and Pechüle − Gill . . . . . = −0ˢ·27 (p. 152).

† In the subsequent computations +3ʰ 41ᵐ 32ˢ·76 was actually used ; having regard to the considerable probable error which must attach to this time determination, the slight difference of 0ˢ·01 has been neglected as altogether immaterial.

that gentleman and Mr. Gill, the errors of these three chronometers are directly known. The fourth chronometer was (43), which, as we have seen, was compared with (36) at the telegraph office. The collected results are :—

Chronometer	Epoch by chronometer	Correction to Belmont time
	h. m.	h. m. s.
(43)	3 35·8	+0 0 53·62 sidereal time
(39)	6 48·7	+3 15 13·92 mean time
(40)	6 26·9	+3 37 59·97 „ „
(38)	6 37·3	+3 27 36·52 „ „

COMPARISONS OF CHRONOMETERS WITH THE STANDARD 36.

Rotation No.	1874, DECEMBER 25						1874, DECEMBER 26						Rotation No.	1874, DECEMBER 25						1874, DECEMBER 26					
	Time by (36)			Time by compared chronometer			Time by (36)			Time by compared chronometer				Time by (36)			Time by compared chronometer			Time by (36)			Time by compared chronometer		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.		h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	19	23	0	19	20	52·0	18	34	0	18	31	50·5	28	19	47	0	19	39	8·0	18	15	0	18	7	6·0
2	19	24	0	19	33	1·5	18	35	0	18	44	1·5	29	19	47	0	19	34	19·0	18	15	0	18	2	16·0
3	19	24	0	19	33	21·5	18	35	0	18	44	23·5	30	19	28	0	19	29	19·5	18	42	0	18	43	24·5
4	19	24	0	19	26	44·0	18	35	0	18	37	42·0	31	20	23	0	20	14	34·0	17	51	0	17	42	29·5
7	19	25	0	19	35	43·5	18	36	0	18	46	45·5	32	19	25	0	19	53§	41·0	18	43	0	19	11	38·0
8	19	26	0	19	26	11·0	18	37	0	18	37	10·0	33	19	29	0	19	23	0·0	18	43	0	18	36	58·0
9	19	26	0	19	28	25·5	18	37	0	18	39	25·0	34	19	30	0	19	15	53·5		...			...	
10	19	27	0	19	33	42·5	18	38	0	18	44	43·0	35	19	30	0	19	24	12·0		...			...	
11	19	27	0	19	42	56·0	18	38	0	18	54	0·0	36	20	23	0		...			...			...	
12	19	55	0	19	44	51·0	18	24	0	18	13	47·5	37	19	31	0	19	26	6·0	18	45	0	18	40	4·5
13	19	56	0	19	48	19·5	18	24	0	18	16	17·0	38	20	0	0	20	13	49·5	18	27	0	18	40	50·5
14	19	54	0	19	47	41·5	18	23	0	18	16	38·5	39	20	1	0	20	26	2·0	18	28	0	18	53	9·5
15	19	34	0	19	27*	3·0	18	23	0	18	16	1·0	40	20	0	0	20	3	23·5	18	28	0	18	31	25·5
16		...			...		18	22	0	18	19	20·5	41‖		...			...			...			...	
17		...			...		18	22	0	18	32	49·5	42	19	31	0	19	23	59·5	18	44	0	18	36	56·5
18	19	53	0	20	0	48·0†	18	21	0	18	28	46·0	43¶	16	0	0		...			...			...	
19	19	53	0	19	43	52·5	18	21	0	18	11	49·5	44	20	0	0	17	56	23·0	18	29	0	16	25	20·5
20	19	52	0	20	5	7·0	18	20	0	18	33	11·0	45	19	39	0	19	21	1·5		...			...	
21	19	43	0	19	44	3·5	18	10	0	18	11	2·5	46	19	39	0	18	36	54·0		...			...	
22	19	44	0	19	42	4·5	18	10	0	17	8	0·5	47	19	38	0	18	37**	57·0	18	5	0	17	4	44·5
23	19	44	0	19	43	49·5	18	11	0	18	10	48·0‡	48	19	37	0	0	21	3·0	18	3	0	22	46	56·0
24	19	45	0	19	48	37·0	18	12	0	18	15	35·5	49	19	38	0	19	41	29·0	18	3	0	18	6	31·0
25	19	45	0	19	45	36·0	18	12	0	18	12	37·0	50	19	32	0	19	21	29·5	18	45	0	18	34	28·0
26	19	46	0	19	22	55·5	18	13	0	17	49	51·0	51	19	37	0	19	25	45·0	18	4	0	17	52	42·0
27	19	46	0	19	24	53·0	18	14	0	17	52	47·0	52	19	36	0	19	9	19·5	18	2	0	17	35	14·0

* 57^m in original. † $1^m\ 53^s{\cdot}0$ in original. ‡ $11^m\ 10^s{\cdot}0$ in original. § 57^m in original.
‖ Chronometer 41 was out of order. ¶ Chronometer 43 is regulated to sidereal time ; the time given is by chronometer 43.
** 32^m in original.

The last table completes the materials for computing the corrections of all the chronometers on December 25 and 26, while similar data for January 5 will be found overleaf. The combination of these affords the rates in the interim. The comparisons on December 26 are chiefly introduced to guard against error *in limine*. This premised, the three next tables sufficiently explain themselves :—

CORRECTIONS OF THE CHRONOMETERS TO BELMONT TIME.

Rotation No.	1874, Dec. 25	1874, Dec. 26	Rotation No.	1874, Dec. 25	1874, Dec. 26
	Chronometer correction	Chronometer correction		Chronometer correction	Chronometer correction
	h. m. s.	h. m. s.		h. m. s.	h. m. s.
1	+3 44 10·96	+3 44 9·72	28	+3 49 54·91	+3 49 54·25
2	3 33 1·46	3 32 58·71	29	3 54 43·91	3 54 44·25
3	3 32 41·46	3 32 36·71	30	3 40 43·45	3 40 35·70
4	3 39 18·96	3 39 18·21	31	3 50 28·84	3 50 30·80
7	3 31 19·45	3 31 14·71	32	3 13 21·95	3 13 22·20
8	3 41 51·95	3 41 50·21	33	3 48 2·95	3 48 2·20
9	3 39 37·45	3 39 35·21	34	3 56 9·44	...
10	3 35 20·45	3 35 17·21	35	3 47 50·94	...
11	3 26 6·95	3 26 0·21	36	3 42 2·84	...
12	3 52 11·90	3 52 12·73	37	3 46 56·94	+3 46 55·69
13	3 49 43·40	3 49 43·23	38	3 28 13·39	3 28 9·73
14	3 48 21·40	3 48 21·74	39	3 17 0·88	3 16 50·73
15	3 48 59·94	3 48 59·24	40	3 38 39·39	3 38 34·73
16	...	3 44 39·74	42	3 49 3·44	3 49 3·70
17	...	3 31 10·74	43*	0 0 11·43	...
18	+3 34 14·90	3 34 14·24	44	5 45 39·89	+3 45 39·73
19	3 51 10·40	3 51 10·74	45	4 0 1·43	...
20	3 28 55·90	3 28 49·24	46	4 44 8·93	...
21	3 40 59·42	3 40 57·76	47	4 42 5·93	+4 42 15·77
22	3 43 58·42	3 43 59·76	48	22 57 59·93	22 58 4·28
23	3 42 13·42	3 42 12·26	49	3 38 33·93	3 38 29·28
24	3 38 25·91	3 38 24·76	50	3 52 33·44	3 52 32·19
25	3 41 26·91	3 41 23·26	51	3 53 17·93	3 53 18·27
26	4 5 7·41	4 5 9·26	52	4 8 43·43	4 8 46·28
27	4 3 9·91	4 3 13·25			

* The correction of this chronometer is to sidereal time.

OPERATIONS AT PORT LOUIS.

COMPARISONS OF CHRONOMETERS WITH THE STANDARD 36, AND THEIR CORRECTIONS TO BELMONT MEAN TIME.

1875, JANUARY 5

Rotation No.	Time by (36)	Seconds of compared chronometer	Chronometer correction	Rotation No.	Time by (36)	Seconds of compared chronometer	Chronometer correction
	h. m. s.	s.	h. m. s.		h. m. s.	s.	h. m. s.
1	3 40 0	21·0	+3 44 11·90	28	4 3 0	40·3	+3 49 52·56
2	,,	6·6	3 32 26·30	29	,,	33·6	3 54 59·26
3	,,	41·8	3 31 51·10	30	4 10 0	10·45	3 39 22·40
4	,,	24·5	3 39 8·40	31	7 59 0	...	3 50 53·83
7	,,	4·1	3 30 28·80	32	4 10 0	6·3	3 13 26·55
8	,,	58·35	3 41 34·55	33	,,	39·5	3 47 53·35
9	,,	23·7	3 39 9·20	34	,,	18·0	3 56 14·85
10	,,	47·35	3 34 45·55	35	,,	43·0	3 47 49·85
11	,,	37·5	3 24 55·40	36	4 56 0	...	3 41 32·76
12	3 55 0	6·95	3 52 25·92	37	4 10 0	50·95	3 46 41·90
13	,,	46·55	3 49 46·32	38	6 23 0	...	3 27 36·52
14	,,	59·5	3 48 33·37	39	6 22 0	...	3 15 13·92
15	,,	38·5	3 48 54·37	40	6 23 0	...	3 37 59·97
16	,,	0·0	3 44 32·87	42	4 10 0	28·55	3 49 4·30
17	,,	54·5	3 30 38·37	43*	3 36 0	...	0 0 53·62
18	,,	25·2	3 33 7·67	44	4 17 0	2·5	5 45 30·33
19	,,	10·3	3 51 22·57	45	,,	16·8	4 0 16·03
20	,,	50·8	3 27 42·07	46	,,	50·7	4 42 42·13
21	4 3 0	58·35	3 40 34·51	47	,,	20·5	3 44 12·33
22	,,	7·0	3 44 25·86	48	,,	36·05	22 58 56·78
23	,,	29·7	3 42 3·16	49	,,	48·3	3 37 44·53
24	,,	2·5	3 38 30·36	50	,,	5·0	3 52 27·83
25	,,	49·05	3 40 43·81	51	,,	9·0	3 53 23·83
26	,,	7·0	4 5 25·86	52	,,	23·8	4 9 9·03
27	,,	26·55	4 4 6·31				

* Chronometer 43 is sidereal, and the time given is by (43).

COMPARISONS OF THE CHRONOMETRICAL THERMOMETER WITH THE STANDARD CHRONOMETER 36, AND THE DEDUCED TEMPERATURES.

(The corrections for chronometer 36 have been interpolated.)

Date, 1874–5	Time by chronometer 36	Belmont mean time	Time by chronometrical thermometer	Correction of chronometrical thermometer	Daily rate of chronometrical thermometer	Deduced temperature
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	s.	°
Dec. 25	20 3 0	23 45 2·9	15 42 34·5	+8 2 28·4	+115·2	83·7 F.
26	18 47 30	22 29 30·1	14 25 12·5	4 17·6	+116·3	83·8
27	18 57 45	22 39 42·2	14 33 27·5	6 14·7	+117·3	84·0
28	17 38 0	21 19 54·5	13 11 49·0	8 5·5	+131·1	86·2
30	19 31 30	23 13 18·5	15 0 40·5	12 38·0	+125·3	85·3
31	19 35 0	23 16 45·6	15 2 2·0	14 43·6	+127·3	85·6
Jan. 1	20 11 0	23 52 42·6	15 35 48·5	16 54·1	+128·8	85·8
2	19 30 30	23 12 9·8	14 53 10·5	18 59·3	+136·0	87·0
4	1 4 30	4 46 6·3	20 24 19·5	21 46·8	+131·3	86·2
5	4 10 0	7 51 33·0	23 27 18·0	24 15·0	+116·4	83·8
7	7 27 0	11 8 27·6	2 40 3·8	28 23·8	+113·0	83·3
8	21 0 0	24 41 23·7	16 10 3·0*	31 20·7	+125·2	85·3
9	20 18 0	23 59 21·3	15 25 59·0	33 22·3	+130·7	86·2
10	20 49 0	24 30 18·8	15 54 43·1	35 35·7	+131·3	86·2
11	21 2 0	24 43 16·2	16 5 28·0	37 48·2	+128·4	85·9
12	21 10 0	24 51 32·7	16 11 35·3	39 57·4	+122·1	84·8
13	21 37 30	25 18 41·2	16 36 38·5	42 2·7	+122·1	84·8
14	20 5 0	23 46 8·8	15 2 11·8	43 57·0	+110·5	82·9
15	20 15 0	23 56 6·3	15 10 18·0	45 48·3	+112·3	83·2
16	20 31 0	24 12 3·8	15 24 22·0	47 41·8	+115·6	83·7
17	20 17 0	23 58 1·3	15 8 25·0	49 36·3	+105·1	82·0
18	20 55 0	24 35 58·7	15 44 34·6	51 24·1	+113·4	83·4
19	21 26 0	25 6 56·2	16 13 36·3	53 19·9	+118·4	84·2
20	22 17 0	25 57 53·5	17 2† 31·0	55 22·5		

* $16^h\ 3^m\ 10^s{\cdot}0$ in original. † Hours and minutes supplied.

In accordance with these temperatures we deduce from the formula in Chapter I. the following table of temperature corrections, where r is the actual *daily* rate between December 25

and January 5 [1] and R the maximum *gaining* rate. For convenience the temperature corrections from Mauritius to Aden are also given in this table :—

Rotation No.	At Belmont			Temperature correction, Mauritius to Aden	Rotation No.	At Belmont			Temperature correction, Mauritius to Aden
	r	Temperature correction	R			r	Temperature correction	R	
	s.	s.	s.	s.		s.	s.	s.	
1	+0·090	−0·720	−0·630	+ 9·11	28	− 0·228	− 1·083	− 1·311	+14·34
2	−3·400	−0·015	−3·415	+ 0·09	29*	+ 1·483	...	+ 1·483	...
3	−4·869	−0·270	−5·139	+ 3·24	30	− 7·822	−0·720	− 8·542	+ 9·11
4	−1·021	−1·371	−2·392	+18·55	31	+ 2·384	−0·965	+ 1·419	+13·17
7	−4·897	−0·429	−5·326	+ 5·36	32*	+ 0·443	...	+ 0·443	...
8	−1·683	−0·518	−2·201	+ 6·54	33	− 0·927	−1·357	− 2·284	+18·15
9	−2·732	−0·801	−3·533	+10·47	34	+ 0·522	−0·411	+ 0·111	+ 5·17
10	−3·375	−0·388	−3·763	+ 4·80	35	− 0·106	−0·175	− 0·281	+ 2·00
11	−6·919	−0·269	−7·188	+ 3·16	36	− 2·905	−0·038	− 2·943	+ 0·28
12	+1·356	−0·941	+0·415	+12·58	37	− 1·452	−0·528	− 1·980	+ 7·51
13	+0·282	−0·042	+0·240	+ 0·40	38	− 3·534	−0·749	− 4·283	+10·15
14	+1·158	−0·618	+0·540	+ 7·85	39	−10·252	−0·679	−10·931	+ 8·52
15	−0·539	−0·231	−0·770	+ 2·64	40	− 3·778	−0·468	− 4·246	+ 6·09
16	−0·730	−0·853	−1·583	+11·00	42	+ 0·082	0·000	+ 0·082	0·00
17	−3·443	−0·682	−4·125	+ 8·69	43	+ 4·025	−0·963	+ 3·062	+12·64
18	...	...	...	...	44	− 0·925	−0·225	− 1·150	+ 2·58
19	+1·177	−0·466	+0·711	+ 5·72	45	+ 1·409	−0·583	+ 0·826	+ 7·13
20*	−7·144	...	−7·144	...	46*	− 8·379	...	− 8·379	...
21*	−2·408	...	−2·408	...	47	+12·200	−2·658	+ 9·542	+37·03
22	+2·652	−2·081	+0·571	+28·58	48	+ 5·486	−2·289	+ 3·197	+30·83
23	−0·992	−2·086	−3·078	+28·82	49	− 4·769	−0·533	− 5·302	+ 6·72
24	+0·430	−0·171	+0·259	+ 1·84	50	− 0·542	−1·039	− 1·581	+14·01
25	−4·166	−0·014	−4·180	+ 0·50	51	+ 0·569	−0·835	− 0·266	+10·80
26	+1·783	−1·637	+0·146	+22·37	52*	+ 2·470	...	+ 2·470	...
27	+5·452	−0·951	+4·501	+12·33					

* For these chronometers there are no temperature tables.

The values of R thus arrived at are the computed rates of maximum gain at which each chronometer would have gone during its trial at Belmont had it been exposed to the special temperature T deduced for it in Chapter I. Subsequently, at Aden, a similar set of values of R were found (see Chapter XIII.) The mean of the two results for any chronometer may then be adopted as the best attainable value of the maximum gaining rate during the voyage. To reduce this rate, corresponding to a temperature T, to the rate in the temperature to which the chronometer was actually exposed from day to day during the voyage, we have to apply the daily temperature corrections, as fully explained in the first chapter. In practice it is more convenient to apply the sum of these corrections for the whole run, which sum is accordingly given in the last column of the preceding table. The duration of the run, from the last comparison at Mauritius to the first at Aden, may be found by comparing the time in the second table on p. 168 with the corresponding time on January 20 as given in Chapter XIII. In point of fact it was about $15\frac{1}{6}$ days. On applying the product of the mean value of R into the number of days in the run, and the sum of the temperature corrections to the correction at Belmont (*ibid.*, col. 4), we obtain the calculated chronometer correction to Belmont time at Aden, as given in the succeeding table. The corresponding Aden correction is shown in the third column of the table and the resulting difference of meridians in the fourth column. The data on which the Aden numbers are based will be given subsequently, also in Chapter XIII.

[1] Except chronometers 16 and 17, which were not compared on December 25; December 26 has been used instead.

Rotation No.	Calculated chronometer correction to Belmont time	Chronometer correction to Aden time	Longitude, Belmont east of Aden	Rotation No.	Calculated chronometer correction to Belmont time	Chronometer correction to Aden time	Longitude, Belmont east of Aden
	h. m. s.	h. m. s.	h. m. s.		h. m. s.	h. m. s.	h. m. s.
1	+3 44 6·49	+2 53 18·07	0 50 48·42	28	+3 49 55·05	+2 59 13·94	0 50 41·11
2	3 31 33·40	2 40 52·97	40·43	29	3 55 10·13	3 4 27·89	42·24
3	3 30 34·57	2 39 45·37	49·20	30	3 37 4·70	2 46 5·82	58·88
4	3 38 51·57	2 48 6·72	44·85	31	3 51 31·40	3 0 54·31	37·09
7	3 29 14·98	2 38 28·97	46·01	32	3 13 28·29	2 22 51·32	36·97
8	3 41 4·10	2 50 22·37	41·73	33	3 47 8·85	2 56 15·47	53·38
9	3 38 24·00	2 47 43·17	40·83	34	3 56 24·90	3 5 42·82	42·08
10	3 33 50·43	2 43 13·37	37·06	35	3 47 45·84	2 57 1·72	44·12
11	3 23 2·17	2 32 15·47	46·70	36	3 40 50·90	2 50 7·18	43·72
12	3 52 40·94	3 1 57·66	43·28	37	3 46 13·56	2 55 28·87	44·69
13	3 49 39·38	2 58 51·46	47·92	38	3 26 37·64	2 35 52·41	45·23
14	3 48 41·29	2 57 56·36	44·93	39	3 12 48·56	2 22 2·46	46·10
15	3 48 35·67	2 57 45·76	49·91	40	3 36 58·06	2 46 12·81	45·25
16	3 44 24·79	2 53 35·96	48·83	42	3 49 3·20	+2 58 19·92	43·28
17	3 29 42·78	2 39 2·41	39·37	43	0 1 53·93	−0 48 49·59	43·52
18*	...	...	...	44	5 45 4·93	+4 54 29·40	35·53
19	3 51 41·04	3 0 57·31	43·73	45	4 0 29·63	3 9 40·50	49·13
20	3 25 43·18	2 34 59·66	43·52	46	4 40 31·75	4 49 41·90	49·85
21	3 39 49·09	2 49 6·94	42·15	47	3 47 16·06	3 56 34·40	41·66
22	3 45 0·85	2 54 25·34	35·51	48	23 0 6·00	22 9 6·90	59·10
23	3 41 38·19	2 50 57·39	40·80	49	3 36 34·29	2 45 56·30	37·99
24	3 38 12·83	2 47 48·14	23·69	50	3 52 15·79	3 1 35·30	40·49
25	3 39 39·59	2 48 55·19	44·40	51	3 53 33·55	3 2 56·30	37·25
26	4 5 51·30	3 15 10·44	40·86	52	4 9 34·62	3 18 47·80	46·82
27	4 5 3·79	3 14 44·44	19·35				

* Chronometer 18 apparently tripped between December 27 and 29.

Dividing these results into groups according to the agreement of the values of R, to lessen the effect of the more unreliable chronometers, we have :—

		Belmont east of Aden
		h. m. s. s.
For those in which the variation of R is less than 0·5 s.	22 chronometers	= 0 50 41·60 ± 0·48
„ „ „ between 0·5 and 1·0	9 „	45·81 ± 0·62
„ „ „ between 1·0 „ 2·0	7 „	46·37 ± 1·88
„ „ „ above 2·0	4 „	38·83 ± 6·81
„ for which there are no temperature corrections	6 „	43·59 ± 1·21

Weighting these values according to their probable errors, we find the probable error of the mean to be $\pm 0^s \cdot 36$. If therefore we assume the probable error of the time determinations and transferences at each end to be $\pm 0^s \cdot 12$, we obtain from the homeward journey of the chronometers :—

Belmont east of Aden . . . . . $0^h\ 50^m\ 43^s \cdot 32 \pm 0^s \cdot 40$

CHAPTER IX.

BELMONT-RÉUNION LONGITUDE.

EARLY on the morning of January 9, 1875, civil reckoning, the 'Dupleix' dropped anchor off St. Denis. Mr. Gill went ashore at 8 A.M. and called on Dr. Oudemans, chief of the Dutch Transit of Venus Expedition to that place, and learnt that observations for time had been secured on the previous evening. After some little delay, caused by the arrangements for departure, Dr. Oudemans accompanied Mr. Gill on board the 'Dupleix' with two chronometers, which were compared with Lord Lindsay's standard chronometer 36, which in its turn was compared with all the other chronometers.

COMPARISON OF CHRONOMETERS.

1875, JANUARY 8.

(36)	Hohwü 502	(36)	Hohwü 514
h. m. s.	h. m. s.	h. m. s.	h. m. s.
20 18 0·0	23 52 39·6	20 21 0	23 54 42·45

The subjoined table contains, first, the comparisons of (36) with the rest of the chronometers on board the 'Dupleix;' then the computed correction of each timekeeper to Belmont time, derived from the corrections on January 5 (p. 168) by the aid of R and the temperature corrections; and, lastly, the derived correction of (36) to Belmont time:—

1875, JANUARY 8

Rotation No.	Time by chronometer 36	Seconds of compared chronometer	Computed correction of chronometer to Belmont mean time	Resulting correction of chronometer 36 to Belmont mean time	Rotation No.	Time by chronometer 36	Seconds of compared chronometer	Computed correction of chronometer to Belmont mean time	Resulting correction of chronometer 36 to Belmont mean time
	h. m. s.	s.	s.	h. m. s.		h. m. s.	s.	s.	h. m. s.
1	20 28 0	13·1	+ 10·35	+3 41 23·45	28	20 47 0	27·4	+ 52·90	+3 41 20·30
2	,,	8·6	13·37	21·97	29	,,	20·4	1·91	22·31
3	,,	50·6	32·31	22·91	30	21 21 0	37·45	48·42	25·87
4	,,	18·35	4·00	22·35	31	,,	18·2	2·57	20·77
7	,,	12·0	10·65	22·65	32	,,	53·75	26·98	20·73
8	,,	54·8	26·96	21·76	33	,,	41·55	42·11	23·66
9	,,	23·6	57·96	21·56	34	,,	4·35	17·19	21·54
10	,,	49·05	31·95	21·00	35	,,	33·6	48·77	22·37
11	,,	54·4	27·65	22·05	36	,,	...	...	22·46
12	20 39 0	53·0	29·37	22·37	37	,,	47·3	34·89	22·19
13	,,	39·0	44·59	23·59	38	,,	59·2	22·24	21·44
14	,,	48·1	35·10	23·20	39	20 53 0	43·3	38·93	22·23
15	,,	35·7	49·69	25·39	40	,,	37·5	45·05	22·55
16		52·6	30·65	23·25	42	,,	18·8	4·03	22·83
17	,,	57·6	24·34	21·94	44	21 42 0	55·25	23·98	19·23
19	,,	55·55	26·91	22·46	45	,,	4·3	19·15	23·45
20	,,	7·1	13·08	20·18	46	,,	17·45	10·11	[27·56*]
21	20 47 0	58·55	23·44	21·99	47	,,	26·3	57·04	23·34
22	,,	48·6	34·01	22·61	48	,,	16·75	13·27	[30·02*]
23	,,	26·45	56·72	23·17	49	,,	53·5	27·11	20·61
24	,,	54·5	25·73	20·23	50	,,	56·9	24·64	21·54
25	,,	54·05	28·19	22·24	51	,,	58·4	25·98	[24·38*]
26	,,	50·5	31·74	22·24	52	,,	8·25	15·32	23·57
27	,,	59·35	20·04	19·39					

[*] Something wrong; not used.

Using for chronometer 36 an hourly rate of $-0^{s}\cdot117$ to reduce all the corrections to one epoch, and dividing the results into groups according to the agreement of the values of R, we have :—

		Computed correction of chronometer 36 at $21^{h}\ 0^{m}$ by (36)
		h. m. s. s.
For those of which the variation of R is less than 0·5 s.	20 chronometers	+3 41 22·05 ± 0·11
„ „ „ between 0·5 and 1·0	9 „	22·65 ± 0·16
„ „ „ between 1·0 „ 2·0	6 „	22·31 ± 0·61
„ „ „ above 2·0	4 „	22·29 ± 1·03
„ for which there are no temperature corrections	5 „	21·76 ± 0·41

Weighting the separate values according to their probable errors, we have :—

			Daily rate
h. m.		h. m. s. s.	s.
At 21 0	by chronometer 36, correction of chronometer 36 to Belmont mean time	+3 41 22·22 ± 0·09	−2·876

The comparisons with (36) then give the corrections of the Dutch chronometers :—

		h. m. s.
h. m.		
At 23 53	by Hohwü 502, correction of Hohwü 502 to Belmont mean time . .	+0 6 42·70
„ 23 55	„ Hohwü 514, „ Hohwü 514 „ „ . .	+0 7 39·85

The corrections of the Dutch chronometers to St. Denis time as supplied by Professor Oudemans from the last observations by Mr. Soeters are :—

St. Denis, Rue du Soleil, $0^{s}\cdot63$ east of the Flagstaff.

1875, January 8, $8^{h}\ 42^{m}\cdot1$ mean time.

	h. m. s.	Daily rate s.
Correction of Hohwü 502	−0 2 8·53	−1·81
„ Hohwü 514	−0 1 12·27	−0·87

Whence, at the times of comparison with Lord Lindsay's chronometers, we have the following corrections to Réunion time :—

	Hohwü 502 m. s.	Hohwü 514 m. s.
Correction	−2 9·67	−1 12·82
Reduction to Flagstaff	−0 0·63	−0 0·63
Correction to Réunion time	−2 10·30	−1 13·45
Correction to Belmont time	+6 42·70	+7 39·85
	8 53·00	8 53·30

Or,

	h. m. s.
St. Denis Flagstaff west of Belmont	0 8 53·15
But Belmont is east of Aden by chronometers (see p. 171) . .	0 50 43·32

Therefore—

St. Denis east of Aden . . . . . 0 41 50·17

CHAPTER X.

BELMONT-SEYCHELLES LONGITUDE.

CONCERNING this operation Mr. Gill writes :—'On the evening of January 13, 1875, about 5 P.M., we reached Seychelles. Owing to the occurrence of measles at Bourbon we were put in quarantine. I had intended to land the altazimuth and get local time here to determine the longitude of Mahé. The captain of the "Dupleix," however, could not lend me a boat to land on the quarantine island ; but fortunately Captain Wharton, commanding H.M.S. "Shearwater," had been detained between Mauritius and Seychelles longer than he had anticipated, and so had not left this station when we arrived. Hearing that we should probably be put in quarantine, he and his officers had observed equal altitudes of the sun, and having obtained a fine series of observations, came to ask the time. After some difficulty as to breach of quarantine, it was arranged that two chronometers might be sent to the "Shearwater."

'Accordingly, chronometers 43 and Nieberg, after being compared with (36) and formally disinfected with vinegar, were placed in a boat and dropped astern, when they were received by Captain Wharton, taken on board the "Shearwater," and compared. They were then similarly returned to the "Dupleix" and again compared'—with (36), which in its turn was compared with chronometers 1–4 and 7–11.

COMPARISONS OF CHRONOMETERS AT SEYCHELLES.

1875, JANUARY 13.

On board S.S. 'Dupleix.'

Before leaving the steamer

	h.	m.	s.		h.	m.	s.		h.	m.	s.		h.	m.	s.
(36)	4	24	40·0	(43)	3	35	20·0	(36)	8	3	0·0	(43)	7	14	14·5
(43)	3	37	5·5	Nieberg	8	6	24·0	(43)	7	15	40·0	Nieberg	11	44	23·5
(36)	4	28	1·15	Nieberg	8	8	0·0	(36)*	8	7	0·0	Nieberg	11	46	58·2

After return on board

On board H.M.S. 'Shearwater.'

	h.	m.	s.		h.	m.	s.		h.	m.	s.		h.	m.	s.
(43)	5	35	35·0	Nieberg	10	4	34·5	(43)	5	57	17·0	Nieberg	10	26	13·0

	h.	m.	s.		h.	m.	s.
Nieberg	10	7	50·0	A. Carter, 211	8	30	58·2
,,	10	8	20·0	B. Lowry, 1656	5	52	32·1
,,	10	8	40·0	C. Hewitt, 732	10	25	58·3
,,	10	9	0·0	D. Baker, 1083	7	32	11·9
,,	10	9	20·0	E. Poole, 1086	1	46	59·2
,,	10	9	40·0	F. Poole, 2681	4	14	21·9
,,	10	10	0·0	G. Chittenden, 779	6	37	19·7

* For the comparisons of (36) with chronometers 1–4 and 7–11 see p. 159.

Time Determinations at Seychelles.

1875, January 13.

Observed Corrections of Chronometers to Mean Time of Houdoul's Jetty at 10 P.M. local mean time (supplied by Captain Wharton).

Observer	A	B	C	D	E	F	G
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
Capt. Wharton	+1 29 12·47	+4 8 8·56	+11 35 2·36	+2 29 8·71	+8 14 41·69	+5 47 38·97	+3 25 0·82
Lieut. Langdon	12·92	9·07	2·74	9·59	42·03	39·33	1·60
„ Moore	12·08	8·18	1·99	8·29	41·29	38·58	0·39
„ Wright	12·60	8·72	2·53	8·82	41·81	39·09	0·92

Or, reduced to Captain Wharton by Personal Equations determined from Eighteen Months' Observations.

Observer	A	B	C	D	E	F	G
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
Capt. Wharton	+1 29 12·47	+4 8 8·56	+11 35 2·36	+2 29 8·71	+8 14 41·69	+5 47 38·97	+3 25 0·82
Lieut. Langdon	12·42	8·57	2·24	9·09	41·53	38·83	1·10
„ Moore	12·98	9·08	2·89	9·19	42·19	39·48	1·29
„ Wright	12·60	8·72	2·53	8·82	41·81	39·09	0·92

As the personal equation between Captain Wharton and Mr. Gill is not known, it has been thought advisable to adopt the unaltered corrections in preference to those corrected for personal equation. We thus have :—

	Correction to Seychelles mean time	Daily rate
	h. m. s.	s.
At 10 P.M. local mean time, A	+1 29 12·52	+1·350
„ „ B	4 8 8·63	+1·119
„ „ C	11 35 2·40	+1·929
„ „ D	2 29 8·85	−2·171
„ „ E	8 14 41·70	+2·109
„ „ F	5 47 38·99	+4·949
„ „ G	3 25 0·94	−4·791

To complete our data we now require the corrections to Belmont time of the chronometers intercompared on board the 'Dupleix' immediately after the transmission of time to the 'Shearwater.' To find these corrections we have recourse to the general comparisons of (36) with the other longitude chronometers before and after the operations at the Seychelles. These comparisons are given in the two next tables, and with them the computed corrections of each timekeeper to Belmont time, derived from the corrections on January 5 (p. 168) and the 'R' and temperature corrections used in the whole run from Mauritius to Aden, and lastly, the corrections of (36) thus given by each chronometer.

1875, JANUARY 12

Rotation No.	Time by chronometer 36	Seconds of compared chronometer	Correction of chronometer to Belmont mean time	Resulting correction of chronometer 36 to Belmont mean time	Rotation No.	Time by chronometer 36	Seconds of compared chronometer	Correction of chronometer to Belmont mean time	Resulting correction of chronometer 36 to Belmont mean time
	h. m. s.	s.	s.	h. m. s.		h. m. s.	h. m. s.	s.	h. m. s.
1	20 38 0	4·7	+ 9·59	+3 41 14·29	28	21 2 0	15·7	+54·34	+3 41 10·04
2	„	10·55	59·44	41 9·99	29	„	5·7	4·79	10·49
3	„	2·2	12·41	41 14·61	30	21 27 0	6·1	12·74	18·84
4	„	11·65	0·41	41 12·06	31	„	54·9	13·10	8·00
7	„	21·2	51·57	41 12·77	32	21 29 0	40·1	27·44	7·54
8	„	50·6	19·40	41 10·00	33	„	42·95	31·29	14·24
9	„	23·3	46·65	41 9·95	34	„	51·7	20·24	11·94
10	„	51·0	17·80	41 8·80	35	„	23·1	47·97	11·07
11	„	14·0	58·09	41 12·09	36	„	...	...	11·42
12	20 48 0	37·2	33·97	41 11·17	37	„	43·25	27·60	10·85
13	„	31·0	42·84	41 13·84	38	„	4·2	7·02	11·22
14	„	35·7	37·76	41 13·46	39	„	10·7	0·78	11·48
15	„	32·2	45·07	41 17·27	40	„	42·4	28·88	11·28
16	„	45·35	29·24	41 14·59	42	21 14 0	7·9	3·74	11·64
17	„	0·2	10·02	41 10·22	43*	21 31 46	20 41 20·2	...	11·29
19	„	39·7	32·29	41 11·99	44	21 40 0	48·6	17·60	6·20
20	„	27·7	41·67	41 9·37	45	„	50·0	23·39	13·39
21	21 2 0	58·2	11·43	41 9·63	46	„	42·4	35·74	18·14
22	„	24·35	44·39	41 8·74	47	„	25·7	46·73	12·43
23	„	19·85	51·15	41 11·00	48	„	51·45	33·01	24·46
24	„	38·75	21·13	40 59·88	49	„	59·45	9·12	8·57
25	„	0·85	11·09	41 11·94	50	„	47·4	22·14	9·54
26	„	30·2	39·39	41 9·59	51	„	36·9	29·24	6·14
27	„	21·2	36·04	+3 40 57·24	52	„	50·9	22·06	12·96

1875, JANUARY 13

Rotation No.	Time by chronometer 36	Seconds of compared chronometer	Correction of chronometer to Belmont mean time	Resulting correction of chronometer 36 to Belmont mean time	Rotation No.	Time by chronometer 36	Seconds of compared chronometer	Correction of chronometer to Belmont mean time	Resulting correction of chronometer 36 to Belmont mean time
	h. m. s.	s.	s.	h. m. s.		h. m. s.	s.	s.	h. m. s.
1	21 5 0	2·55	9·29	+3 41 11·84	16	21 13 0	43·3	28·77	+3 41 12·07
2	„	11·1	55·89	41 6·99	17	„	0·7	6·28	41 6·98
3	„	5·05	7·29	41 12·34	19	„	35·6	33·56	41 9·16
4	„	9·8	59·35	41 9·15	20	„	33·15	33·69	41 6·84
7	„	23·6	46·65	41 10·25	21	21 23 0	58·25	8·39	41 6·64
8	„	49·55	17·40	41 6·95	22	„	18·6	46·83	41 5·43
9	„	23·3	43·66	41 6·96	23	„	18·65	49·57	41 8·22
10	„	51·55	14·13	41 5·68	24	„	34·8	19·91	40 54·71
11	„	19·2	50·50	41 9·70	25	„	2·2	6·77	41 8·97
12	21 13 0	33·35	35·03	41 8·38	26	„	25·5	41·17	41 6·67
13	„	28·85	42·39	41 11·24	27	„	12·2	39·95	40 52·15
14	„	32·6†	38·34	41 10·94	28	„	12·8	54·58	41 7·38
15	„	31·25	43·84	41 15·09	29	„	1·8	5·51	7·31

* (43) is a sidereal chronometer.

† 42ˢ·6 in original.

1875, JANUARY 13—*continued.*

Rotation No.	Time by chronometer 36	Seconds of compared chronometer	Correction of chronometer to Belmont mean time	Resulting correction of chronometer 36 to Belmont mean time	Rotation No.	Time by chronometer 36	Seconds of compared chronometer	Correction of chronometer to Belmont mean time	Resulting correction of chronometer 36 to Belmont mean time
	h. m. s.	s.	s.	h. m. s.		h. m. s.	h. m. s.	s.	h. m. s.
30	21 41 0	13·65	3·64	+3 41 17·29	42	21 31 0	5·3	3·67	+3 41 8·97
31	,,	49·5	15·68	5·18	43	21 45 0	20 58 25·6	...	8·09
32	21 43 0	36·7	27·55	4·25	44	21 51 0	47·0	15·93	2·93
33	,,	44·5	28·40	12·90	45	,,	46·75	24·34	11·09
34	,,	48·05	20·93	8·98	46	,,	47·85	27·08	14·93
35	,,	20·7	47·72	8·42	47	,,	10·5	59·02	9·52
36	,,	...	...	8·62	48	,,	44·15*	37·73	21·88
37	,,	42·55	25·73	8·28	49	,,	0·7	4·48	5·18
38	,,	5·7	3·12	8·82	50	,,	45·25	21·40	6·65
39	,,	17·9	51·11	9·01	51	,,	33·7	29·95	3·65
40	,,	43·5	24·77	8·27	52	,,	46·6	23·76	10·36

* 34ˢ·15 in original.

Using for chronometer 36 an *hourly* rate of $-0^{s}\cdot116$ to reduce the corrections on each day to one epoch, and dividing the chronometers into groups, according to the stability of R, we get—

1875, JANUARY 12.

		Deduced correction of chronometer 36 at 21ʰ 0ᵐ by (36)
	s. s.	h. m. s. s.
In which the variation of R is less than 0·5	22 chronometers	+3 41 10·59 ± 0·27
,, ,, between 0·5 and 1·0	9 ,,	12·23 ± 0·33
,, ,, between 1·0 ,, 2·0	7 ,,	13·84 ± 1·49
,, ,, above 2·0	4 ,,	7·58 ± 3·59
For which there are no temperature corrections	6 ,,	11·39 ± 1·04

1875, JANUARY 13.

		Deduced correction of chronometer 36 at 21ʰ 0ᵐ by (36)
	s. s.	h. m. s. s.
In which the variation of R is less than 0·5	22 chronometers	+3 41 7·72 ± 0·29
,, ,, between 0·5 and 1·0	9 ,,	9·68 ± 0·36
,, ,, between 1·0 ,, 2·0	7 ,,	11·27 ± 1·54
,, ,, above 2·0	4 ,,	4·32 ± 4·28
For which there are no temperature corrections	6 ,,	8·45 ± 1·04

Combining these results with due regard to their probable errors, we obtain as corrections of chronometer 36 to Belmont mean time at the epochs of the two general comparisons :—

		Daily rate
	h. m. s.	s.
1874, Jan. 12, at 21 0 by chronometer 36, correction of chronometer 36 to Belmont mean time	+3 41 11·28	−2·77
,, 13 ,, 21 0 ,, ,, ,, ,,	8·51	

Returning again to the general comparisons, these numbers afford the following corrections to Belmont mean time for the chronometers 1—4, 7—11, 'Nieberg' and 43, based on the going of the whole of the timekeepers :—

Rotation No.	1875, January 12		1875, January 13		Resulting *daily* rate
	Time by chronometer 36	Correction of compared chronometer	Time by chronometer 36	Correction of compared chronometer	
	h. m. s.	s.	h. m. s.	s.	s.
1	20 38 0	+ 6·62	21 5 0	+ 5·95	−0·658
2	,,	0·77	,,	57·40	−3·308
3	,,	9·12	,,	3·45	−5·565
4	,,	59·67	,,	58·70	−0·952
7	,,	50·12	,,	44·90	−5·124
8	,,	20·72	,,	18·95	−1·737
9	,,	48·02	,,	45·20	−2·768
10	,,	20·32	,,	16·95	−3·308
11	,,	57·32	,,	49·30	−7·872
Nieberg	21 51 0	11·18*	22 1 0	12·34*	+1·152
43 (sid.)	Time by (43) 20 41 20	+24·85	Time by (43) 20 58 25	+29·38	+4·489

	(36)	Nieberg
	h. m. s.	s.
* January 12	21 51 0	0·0
,, 13	22 1 0	56·05

Applying these corrections to the subjoined comparisons with (36), and also taking into account the rate of that chronometer, we obtain twelve separate values of its correction to Belmont time, immediately succeeding the communications with the 'Shearwater':—

1875, January 13			
Rotation No.	Time by chronometer 36	Seconds of compared chronometer	Computed correction of chronometer 36 reduced to $8^h\ 22^m$ by (36)
	h. m. s.	s.	h. m. s.
1	8 22 0	3·55	+3 41 9·85
2	,,	10·55	9·70
3	,,	3·65	10·05
4	,,	10·6	9·80
7	,,	22·35	9·97
8	,,	49·95	9·82
9	,,	23·4	10·07
10	,,	51·1	9·80
11	,,	16·5	9·97
Nieberg	8 7 0	58·2	9·84
43*	...	...	9·76
Its own rate	...	...	9·97

* (43) = $7^h\ 14^m\ 14^s·5$ (36) = $8^h\ 3^m\ 0^s·0$

Or as the final value—

			Hourly rate
h. m.		h. m. s.	s.
At 8 22 by chronometer 36, correction of chronometer 36 to Belmont mean time		+3 41 9·88	−0·1227

From the comparisons of chronometers 36 and 43 and 'Nieberg' (p. 174), we then find the corrections of the chronometers sent on board the 'Shearwater':—

				h.	m.	s.
At 3	35·3	by chronometer 43,	correction of chronometer 43 to Belmont sidereal time	+0	1	26·03
„ 7	14·2	„	„ „			26·95
At 8	6·4	by 'Nieberg,'	correction of 'Nieberg' to Belmont mean time . .	+0	1	11·59
„ 11	44·4	„	„ „ .			11·70

These corrections then give the Belmont mean times, while from pp. 174 and 175 we have the corresponding Seychelles mean times at the epochs of the comparisons with the 'Shearwater' chronometers, and thence the difference of meridians.

1875, JANUARY 13

Belmont mean time		Seychelles mean time by chronometer		Resulting longitude, Seychelles west of Belmont	
h. m. s.		h. m. s.		h. m. s.	
10 9 1·65	A	10 0 10·72		0 8 50·93	
10 9 31·65	B	10 0 40·73			50·92
10 9 51·65	C	10 1 0·70			50·95
10 10 11·65	D	10 1 20·75			50·90
10 10 31·65	E	10 1 40·90			50·75
10 10 51·65	F	10 2 0·90			50·75
10 11 11·65	G	10 2 20·62			51·03

Taking the mean, we have Seychelles west of Belmont $0^h\ 8^m\ 50^s{\cdot}89$; or finally, by calling in the aid of the result arrived at in Chapter VIII. :—

	h.	m.	s.
Seychelles (Houdoul's Jetty) east of Aden . . .	0	41	52·43

This result is entirely uncorrected for personal equation of any kind.

CHAPTER XI.

INTRODUCTION TO THE BERLIN-ADEN-BOMBAY TELEGRAPHIC LONGITUDES.

WHETHER Aden is considered as the starting-point for the chronometrical determinations of the longitude of the various groups of islands in the Indian Ocean, including those at which the transit of Venus was observed, or whether it is used as an intermediate station in connecting the longitudes of the East with those of Western Europe, its position is equally important. As soon, therefore, as it was decided to transport chronometers between Aden and Mauritius, a correspondence was entered into with Professor Auwers, who, on behalf of the German Government, arranged that one of their expeditions, equally interested in the result, should co-operate with Lord Lindsay on the journey home in finding the longitude of Aden, provided the use of the various telegraphic lines could be obtained. On applying to the companies, they at once generously gave the use of their wires, and gratuitously afforded every assistance required.

The selection from the German expeditions fell upon the one to Solitude, the chief of which, Dr. Löw, observed at Suez and Malta in conjunction with Mr. Gill at Aden and Alexandria, and also with Professor Auwers and the astronomers of the Berlin Observatory at Berlin. Thus the following differences of longitude were determined :—

Aden	—	Suez
Suez	—	Alexandria
Alexandria	—	Malta
Alexandria	—	Berlin
Malta	—	Berlin

Dr. Löw observed with the Pistor and Martins' broken transit instrument, a description of which has already been given in Chapter IV., p. 112.

Mr. Gill used the Troughton and Simms' altazimuth, so often mentioned.

The time determinations are generally very complete; in a few cases, where the observations are not satisfactory, the chronometer comparisons have been utilised to carry on the time.

Three good determinations of difference of personal equation between Dr. Löw and Mr. Gill in determining the time with their different instruments were made at Suez and Alexandria, and Dr. Löw on his arrival at Berlin made a similar determination with the Berlin observers, so that all the time determinations can be reduced to one standard.

Signals were sent from each station at intervals of ten seconds, either omitting one signal in each minute, or sending one at an odd second to identify the corresponding signals. Between Aden and Suez, and between Alexandria and Malta, the 'Thomson' galvanometer was used, the signals being observed by counting the beats of the chronometer and watching

the flash of light. While at Suez, Dr. Löw and Mr. Gill made a thorough determination of their personal difference in noting the times of these flashes. On the other lengths relays were used, but no determination of personal difference was made; the difference in the case of the galvanometer amounts to $0^s{\cdot}03$, which has been applied where necessary. No correction has been applied to the results of the observations with the relay.

The signals between Alexandria and Berlin, and between Malta and Berlin, were sent on a slightly different plan to that previously adopted; the observers at these stations endeavouring to send the signals *exactly* at every 10^s by the beat of the chronometer, one observer using a sidereal and the others a mean-time chronometer, so as to determine when the chronometers were exactly beating in unison, but in reducing the observations every available signal has been used. From subsequent observations it was found that the difference between Professor Auwers and Dr. Löw in *observing* signals was imperceptible, but Professor Auwers *sent* signals $0^s{\cdot}065$ before the beat of the chronometer, and Dr. Löw $0^s{\cdot}013$ after the beat, while Mr. Gill *sent* signals too soon by $0^s{\cdot}02$. It will thus be seen that, with the exception of observing signals with the relay, in which Mr. Gill took part, all personality can be allowed for; but, as Mr. Gill occupied Alexandria (a middle station), and Dr. Löw successively occupied Suez and Malta, while the Berlin observations can be referred to Dr. Löw by the determination of the absolute errors of Professor Auwers and Dr. Löw in sending signals, all personality, as far as Mr. Gill is concerned, disappears in the whole length, Suez–Berlin, but not in the intermediate lengths, which still remain uncorrected for the difference between Dr. Löw and Mr. Gill in sending and receiving signals with the relay.

With all these precautions to eliminate personality, it is trusted that the possible errors of the results herewith submitted are confined within narrow limits; of course the different strengths of the batteries and springs of the relays it is impossible to allow for, but by sending signals in both directions these sources of errors are either wholly or partially eliminated. In how far this has been done will be seen by the agreement of the various current times given with each longitude.

While at Aden the opportunity was taken of exchanging signals with the Bombay Observatory, but as no personal equations could be determined, the resulting difference of meridians is uncertain to their full amount. At Suez Mr. Gill connected the station occupied by the British Government expedition for observing the transit of Venus with Lord Lindsay's longitude station, so as to afford a comparison between the independent results of each party.

CHAPTER XII.

OPERATIONS AT BOMBAY. BOMBAY-ADEN LONGITUDE.

Time Determinations.

A letter from Mr. C. Chambers, the Director of the Bombay Observatory, to Mr. Gill, which we give *in extenso*, contains, with its enclosures, full particulars of the observations at Bombay.

'Coluba Observatory, Bombay : April 12, 1875.

'My dear Sir,—With this I send you (by book post, registered) a packet containing the following papers :—

'1 sheet of transit observations with attachment.

'2 sheets of determinations of collimation and level errors.

'1 sheet of comparisons of chronometer No. 411 (used for signalling) and sidereal clock—through chronograph.

'1 sheet of chronometer times of signals.

'1 sheet of Bombay mean times (corrected tentatively) of both sets of signals.

'2 sheets of remarks and experiments by Mr. Saunders on the electrical arrangements.[1]

'I think you will find that all the data necessary for an independent reduction of the observations are given ; but I have had the times worked out (with tentative corrections of the transit instrument) to enable you to get at an approximate result pretty readily.

'It was a mistake, I think, to reverse the pivots of our ponderous transit instrument at the time ; it ought to have been used in the usual way—*lamp east only*—and a correction found at leisure for inequality of the pivots ; but your arrangements left me no opportunity of advising you to let your plan be modified on that point, and accordingly I followed your instructions to the letter. The agreement of the several groups of clock errors is decidedly inferior to our ordinary results, notwithstanding the aim at refinement in the use of a makeshift chronograph. The transit instrument is by Gilbert of London—a 5-foot telescope with 3-foot axis and $3\frac{1}{2}$-inch object-glass—and it has a beautiful set of wires made by Merz of Munich, a glass plate with lines scratched by a diamond point, but it has no micrometer. The collimation error is determined by means of a collimator mark with micrometer movement ; and the level error by means of a spirit level which is suspended on pivots attached to the conical part of the axis of the instrument, and remains in position for observation as the transit swings round.

'There is an evident displacement of the transit in azimuth between some of the reversals ; for the two sets of observations of the collimator mark show a change of nearly $2''$, and so do the two transits of Polaris.

'In order to diminish personal error, we got the loan of a Siemens' ink-writer to serve, in connection with a spare mean-time clock, as a galvanic chronograph.

'The method of using this is not the ordinary one, in which the times are taken from the

[1] It has not been thought necessary to print these.

chronograph; but it serves only as an intermediary between the sidereal clock, which we treat as the standard time-keeper, and the chronometer, or the passage of a star; and the small interval between the two events (say) the transit of the star and the comparison of the sidereal clock, which are both recorded in the chronograph, is all that it is trusted to determine. Either from irregularity in the going of the chronograph clock, or from irregularity in the tapping of the comparisons, even this small interval seems, however, to be less certainly determined than previous experience has led us to expect it would be; and it is a matter for the consideration of the final computer whether allowance should be made for a rate of the chronograph determined from the six even second taps of the sidereal clock time made immediately after each transit, or whether the chronograph should be regarded as having kept, sufficiently nearly, true mean time, and the apparent irregularities be treated as errors of the operator.

'I should mention that the driving power of the chronograph clock was, during part of the transit observations, scarcely equal to the extra work of making the galvanic contacts, and on one or two occasions, before extra weight was added, it even ceased to tick, but not to swing nor to write down the seconds-contacts on the recording tape.

'The signals were made by Mr. F. Chambers, and the transit observations taken by Mr. Harry Chintaman, but the relative personal error of these two observers, observing transits by the chronograph in the manner described above, is doubtless very small, for on December 8 last, Mr. F. Chambers observing three stars, and Mr. Harry Chintaman two stars, the difference of mean clock error found was—

'Mr. F. Chambers – Mr. Harry Chintaman . . . . $= +0^{s}\cdot03$

'The chronograph tapes had better be sent to you if you think they ought to be preserved; let me know, please, if I should send them.

'Any points not mentioned above upon which you require information will, I think, be found to be explained in the tabular sheets. If I have omitted to mention any essential particulars kindly let me know, and believe me to be

'Yours sincerely,

'(Signed) CHARLES CHAMBERS,

'Superintendent Government Observatory.

'P.S.—The active direction of the operations at this end lay with Mr. F. Chambers, my own part being confined nearly to consultation.

'To David Gill, Esq.'

Appended to the observations are the following remarks:—

'The sidereal clock has a gridiron pendulum, and is somewhat over-compensated, but the temperature correction is not known. The approximate mean temperatures were—of Group I., $63^{\circ}\cdot6$; Group II., $73^{\circ}\cdot1$; and Group III., $68^{\circ}\cdot5$.

'The comparisons of the sidereal clock immediately after the transits show signs of irregularity of rate of the chronograph, or rather of the mean-time clock with which it was connected; but the full day's rates, as shown at the foot of the observations, were small and nearly equal—i.e. about six seconds—or the differences may be attributed to irregularity in tapping the beats of the sidereal clock, but if so, the chronometer comparisons were remarkably free from the fault.'

THE FOLLOWING TRANSIT OBSERVATIONS WERE TAKEN BY MR. HARRY CHINTAMAN, THOSE OF

Time in seconds of mean time

Date, 1875	Star	Position of lamp	Transits over wires										
1	2	3	4									5	
			A s.	B s.	C s.	D s.	E s.	F s.	G s.	H s.	I s.	m.	s.
Jan. 30	Polaris S.P.	E	54·0	30·0	43·0	56·0	7·0	20·0	30·0	44·0	24·0	12	7·56
	ζ Virginis	„	18·29	31·82	36·35	40·93	45·60	50·00	54·65	59·15	12·64	0	45·49
	η Ursæ majoris	„	22·95	44·17	51·30	58·19	4·95	12·19	19·32	26·40	47·50	1	5·22
	η Boötis	„	42·65	56·80	1·18	6·52	11·40	16·17	20·97*	25·67	40·10	1	11·27
	α Boötis	W	53·40	39·00	34·04	29·30	24·46	19·69	14·78	10·15	55·64	1	24·50
	ρ Boötis	„	25·70	9·88	4·36	59·16	53·90	48·69	43·47	38·00	22·28	0	53·94
	α Libræ	„	52·63	38·26	33·70	29·15	24·31	19·54	14·94	10·25	56·00	1	24·31
Jan. 31	γ^1 Eridani	W	5·93	51·85	47·17	42·70	38·00	33·00	28·60	24·00	10·00	0	37·92
	o^1 Eridani	„	40·89	27·00	22·52	17·86	13·39	9·00	...	59·83	46·00	0	13·39
	ε Tauri	„	15·00	0·55	55·80	50·95	46·39	41·38	36·53	31·88	17·42	0	46·21
	α Tauri	„	40·11	26·00	21·29	16·65	12·00	7·15	2·40	57·52	43·61	0	11·86
	ι Aurigæ	„	50·85	34·55	29·19	23·86	18·18	12·75	7·47	2·00	45·90	0	18·31
	ε Leporis	E	7·00	21·90	26·81	31·70	36·56	41·39	46·51	51·23	6·00	0	36·57
	β Tauri	„	19·00	34·45	39·78†	44·80	50·00	55·09	0·34	5·52	20·90	0	49·99
	δ Orionis	„	36·36	49·70	54·47	59·00	3·48	8·00	12·60	17·15	30·64	0	3·49
	ε Orionis	„	...	4·71	9·46	13·73	18·65	22·94	27·76	32·23	45·86	0	18·50
	α Orionis	„	23·28	37·37	41·61	46·30	50·61	55·38	0·00	4·45	18·15	0	50·79
	ν Orionis	„	24·28	38·42	43·10	48·11	52·60	57·39	1·90	6·70	20·64	0	52·57
Jan. 31	η Virginis	E	39·39	52·92	57·45	2·00	6·66	11·00	15·54	20·20	33·70	1	6·54
	α Canum Venat.	„	2·08	19·70	25·57	31·40	37·10	42·86	48·86	54·62	12·25	0	37·16
	Polaris S.P.	„	57·0	35·0	48·0	0·0	11·0	22·0	34·0	47·0	28·0	12	11·33
	ζ Virginis	„	17·30	30·95	35·21	39·91	44·39	48·90	53·40	57·95	11·43	0	44·38
	η Ursæ majoris	„	21·50	42·52	49·35	56·40	3·50	10·41	17·64	24·56	45·61	1	3·50
	η Boötis	„	30·80	45·23	50 33	54·96	59·78	4·58	9·40	14·15	28·55	0	59·75
	α Boötis	W	52·08	37·49	32·75	27·84	22·94	18·12	13·19	8·49	54·09	0	23·00
	ϵ^2 Boötis	„	27·55	12·40	7·22‡	2·22	57·04	52·00	46·94	41·58	26·50	0	57·05
	α Libræ	„	51·23	36·84	32·12	27·28	22·84	18·10	13·38	8·73	54·44	0	22·77

* 21·97 in copy received from Bombay.

† 38·78 in copy received from Bombay.

‡ 5·22 in copy received from Bombay.

POLARIS BY EYE AND EAR, AND THE REST BY GALVANIC CHRONOGRAPH (A SIEMENS' INK-WRITER).

(except for Polaris) by chronograph									
Six even seconds of the sidereal clock tapped on the chronograph							Column 7 *minus* column 5 corrected and converted into sidereal time	Time by sidereal clock corresponding to mean of six even seconds tapped on chronograph	Time by sidereal clock of transit ; column 9 *minus* column 8
6						7	8	9	10
s.	s.	s.	s.	s.	s.	m. s.	s.	h. m. s.	h. m. s.
...	...	...	...	...	...	...	...	...	13 12 7·56
20·24	22·15	24·16	26·11	28·09	30·19	1 25·16	39·78	13 29 25·0	13 28 45·22
50·95	52·91	54·79	56·70	58·80	0·80	2 55·82	50·74	13 43 55·0	13 43 4·26
51·02	53·00	54·94	56·89	58·80	0·80	1 55·91	44·76	13 49 55·0	13 49 10·24
10·21	12·15	14·02	16·01	18·08	20·19	2 15·11	50·75	14 11 15·0	14 10 24·25
40·60	42·55	44·50	46·32	48·32	50·22	1 45·42	51·62	14 27 45·0	14 26 53·38
0·96	2·94	4·93	6·86	8·95	10·92	2 5·93	41·73	14 45 5·0	14 44 23·27
19·94	21·94	23·94	25·94	27·94	29·92	1 24·94	47·15	3 53 25·0	3 52 37·85
51·63	53·63	55·59	57·60	59·55	1·66	0 56·61	43·34	4 6 55·0	4 6 11·66
21·15	23·05	25·16	27·18	29·14	31·19	1 26·14	40·04	4 22 25·0	4 21 44·96
50·94	52·94	54·94	56·90	58·88	0·88	0 55·91	44·17	4 29 55·0	4 29 10·83
0·55	2·52	4·50	6·50	8·52	10·50	1 5·51	47·33	4 50 5·0	4 49 17·67
20·62	22·50	24·50	26·50	28·50	30·50	1 25·52	49·08	5 1 25·0	5 0 35·92
30·50	32·50	34·42	36·35	38·35	40·32	1 35·41	45·54	5 19 35·0	5 18 49·46
50·30	52·27	54·14	56·09	58·12	0·12	0 55·17	51·82	5 26 55·0	5 26 3·18
0·40	2·35	4·25	6·20	8·24	10·19	1 5·27	46·90	5 31 5·0	5 30 18·10
30·35	32·30	34·30	36·20	38·25	40·25	1 35·27	44·60	5 49 35·0	5 48 50·40
30·54	32·56	34·54	36·52	38·48	40·49	1 35·52	43·07	6 1 35·0	6 0 51·93
40·66	42·50	44·51	46·49	48·52	50·50	1 45·53	39·10	12 14 35·0	12 13 55·90
20·44	22·40	24·42	26·44	28·42	30·49	1 25·43	48·40	12 51 25·0	12 50 36·60
...	...	...	...	...	...	...	...	...	13 12 11·33
20·08	22·05	24·02	26·00	28·00	30·00	1 25·02	40·75	13 29 25·0	13 28 44·25
50·77	52·75	54·78	56·79	58·79	0·78	1 55·78	52·42	13 43 55·0	13 43 2·58
50·72	52·70	54·57	56·62	58·61	0·60	1 55·64	56·04	13 50 5·0	13 49 8·96
0·18	2·12	4·10	6·10	8·00	10·00	1 5·08	42·20	14 11 5·0	14 10 22·80
40·15	42·10	44·20	46·10	48·08	50·10	1 45·12	48·20	14 40 45·0	14 39 56·80
0·45	2·44	4·49	6·34	8·34	10·40	1 5·41	42·76	14 45 5·0	14 44 22·24

1875, *January* 30.—The collimation error is observed by means of a collimator mark with micrometer movement, placed to northward of transit instrument; the angular value of one division of the micrometer is 3″·69, and when the readings increase the movement of the mark is really to westward.

One revolution of the micrometer head = 60 divisions.

READINGS FOR COLLIMATION CORRECTION.

Lamp East						Lamp West					
Wires	Readings of the collimator micrometer					Wires	Readings of the collimator micrometer				
	1st set	2nd set	Means	Converted			1st set	2nd set	Means	Converted	
A	...	...	[43·18*]	43·18	...	I	...	...	[41·80*]	41·80	...
B	38·20	38·20	38·20	98·20	...	H	36·90	36·90	36·90	96·90	...
C	56·40	56·50	56·45	116·45	...	G	54·30	54·20	54·25	114·25	...
D	14·50	14·50	14·50	134·50	...	F	12·75	12·80	12·77	132·77	...
E	33·20	33·00	33·10	153·10	...	E	31·20	31·20	31·20	151·20	...
F	53·10	53·00	53·05	173·05	...	D	50·10	50·25	50·17	170·17	...
G	10·75	10·75	10·75	190·75	...	C	8·80	8·50	8·65	188·65	...
H	29·05	29·20	29·12	209·12	...	B	27·10	27·00	27·05	207·05	...
I	23·90	23·90	23·90	263·90	153·58	A	21·10	21·10	21·10	261·10	151·54

[*] Interpolated by use of mean intervals between A and B, and I and H, given by many previous sets of observations.

Mean of easterly readings . . . . . 153·58
Mean of westerly readings . . . . . 151·54
} 2·04 and 1·02 × ·246 = s. −0·23, −0·251†

Collimation correction = s. −0·23 = ″ −3·45
Adopted value −0·251 = −3·76

† In this and other instances where two values are given, the first is Mr. Chambers' tentative quantities; the second, which is the result of a re-computation, has invariably been used.

READINGS FOR LEVEL CORRECTION.

The value of one division of the level is 0″·765.

Transit instrument, horizontal, pointing towards	Lamp East				Lamp West			
	Small level E		Small level W		Small level E		Small level W	
	E	W	E	W	E	W	E	W
South	35·6	32·5	39·0	29·0	27·8	40·3	36·7	31·3
North	28·6	39·0	33·5	34·0	19·0	49·0	33·1	35·0
Mean	32·10	35·75	36·25	31·50	23·40	44·65	34·90	33·15

Mean of easterly readings (lamp east) . . . . 34·17
Mean of westerly readings (lamp east) . . . . 33·62
} 0·55 and −0·275 × ·051 = −0″·014, −0″·210

Mean of easterly readings (lamp west) . . . . 29·15
Mean of westerly readings (lamp west) . . . . 38·90
} 9·75 and 4·875 × ·051 = +0″·248, +3″·730

Level correction = s. +0·12 = ″ +1·80
Adopted value +0·117 = +1·76

READINGS FOR COLLIMATION.

Lamp East						Lamp West					
Wires	Readings of the collimator micrometer					Wires	Readings of the collimator micrometer				
	1st set	2nd set	Means	Converted			1st set	2nd set	Means	Converted	
A	42·50	42·00	42·25	42·25	...	I	41·00	40·50	40·75	40·75	...
B	37·60	37·40	37·50	97·50	...	H	36·10	36·50	36·30	96·30	...
C	56·00	55·50	55·75	115·75	...	G	54·50	54·30	54·40	114·40	...
D	14·40	13·50	13·95	133·95	...	F	12·40	12·50	12·45	132·45	...
E	32·50	32·00	32·25	152·25	...	E	31·30	31·20	31·25	151·25	...
F	52·00	52·00	52·00	172·00	...	D	50·10	50·00	50·05	170·05	...
G	10·10	10·00	10·05	190·05	...	C	8·10	8·25	8·17	188·17	...
H	28·55	28·60	28·57	208·57	...	B	27·10	27·10	27·10	207·10	...
I	23·50	23·50	23·50	263·50	152·87	A	21·10	21·10	21·10	261·10	151·29

Mean of easterly readings . . . . 152·87
Mean of westerly readings . . . . 151·29
} 1·58 and $0.79 \times .246 = -0^{s}.19$

Collimation correction = $-0^{s}.19 = -2''.85$
Adopted value . . $-0^{s}.195 = -2''.92$

READINGS FOR LEVEL CORRECTION.

Transit instrument, horizontal, pointing towards	Lamp East				Lamp West			
	Small level E		Small level W		Small level E		Small level W	
	E	W	E	W	E	W	E	W
South	32·0	28·5	34·5	26·0	28·7	33·5	29·4	32·9
North	30·5	30·0	31·5	29·0	27·8	35·0	29·0	33·8
Mean	31·25	29·25	33·00	27·50	28·25	34·25	29·20	33·35

Mean of easterly readings (lamp east) . . . . 32·12
Mean of westerly readings (lamp east) . . . . 28·37
} 3·75 and $1.87 \times .051 = -0^{s}.10$, $-0^{s}.096$

Mean of easterly readings (lamp west) . . . . 28·72
Mean of westerly readings (lamp west) . . . . 33·80
} 5·08 and $2.54 \times .051 = +0^{s}.13$, $+0^{s}.129$

Level correction = $+0^{s}.01 = +0''.15$
Adopted value . $+0^{s}.016 = +0''.25$

The Instrumental Corrections.

The mean level, as derived from the observations of January 30 and February 1, has been used throughout. The observations in different positions of the instrument indicate an inequality of pivots, but are not sufficiently numerous to afford a reliable determination of its amount. This, however, does not affect the time results, which are derived from observations in reversed positions of the instrument.

The adopted level correction is $+0^{s}.066$.

The collimation correction deduced from the collimator readings already given is opposite in sign to that indicated by the observations themselves. It has been thought best under these circumstances to deduce a separate collimation correction from each group of observations made in reversed positions of the instrument.

These are for *lamp east* :—

Date		s.
Jan. 30	Group I.	+0·245
„ 31	„ II.	+0·136
„ 31	„ III.	+0·228

The azimuth corrections were derived from the observations of Polaris in Group I. and III., the mean value being adopted for Group II.

These are :—

Date		
Jan. 30	Group I.	+1·137
„ 31	„ II.	[+1·056]
„ 31	„ III.	+0·974

These corrections are applied in the next table, where the fourth column is identical with the last column on p. 185. The right ascensions are taken from the list used throughout except for Polaris, for which the 'Nautical Almanac' place is adopted.

Date, 1875	Star	Position of lamp	Transit by sidereal clock	Sum of instrumental corrections	Star's R.A. corrected for daily aberration	Clock correction
			h. m. s.	s.	h. m. s.	s.
Jan. 30	Polaris S.P.	E	13 12 7·56	...	1 12 16·19	...
	ζ Virginis	„	13 28 45·22	+0·67	13 28 19·83	−26·06
	η Ursæ maj.	„	13 43 4·26	−0·44	13 42 37·89	−25·93
	η Boötis	„	13 49 10·24	+0·33	13 48 44·40	−26·17
	α Boötis	W	14 10 24·25	−0·21	14 9 57·91	−26·13
	ρ Boötis	„	14 26 53·38	−0·48	14 26 26·92	−25·98
	α Libræ	„	14 44 23·27	+0·48	14 43 57·74	−26·01
Jan. 31	γ^1 Eridani	W	3 52 37·85	+0·51	3 52 12·37	−25·99
	o^1 Eridani	„	4 6 11·66	+0·39	4 5 46·40	−25·65
	ε Tauri	„	4 21 44·96	−0·07	4 21 19·64	−25·25
	α Tauri	„	4 29 10·83	−0·02	4 28 45·53	−25·28
	ι Aurigæ	„	4 49 17·67	−0·39	4 48 52·01	−25·27
	ε Leporis	E	5 0 35·92	+0·96	5 0 11·09	−25·79
	β Tauri	„	5 18 49·46	+0·03	5 18 24·36	−25·13
	δ Orionis	„	5 26 3·18	+0·55	5 25 38·14	−25·59
	ε Orionis	„	5 30 18·10	+0·56	5 29 53·18	−25·48
	α Orionis	„	5 48 50·40	+0·42	5 48 25·26	−25·56
	ν Orionis	„	6 0 51·93	+0·29	6 0 27·17	−25·05
Jan. 31	η Virginis	E	12 13 55·90	+0·60	12 13 31·40	−25·10
	α Canum venat.	„	12 50 36·60	−0·06	12 50 11·91	−24·63
	Polaris S.P.	„	13 12 11·33	...	1 12 15·42	...
	ζ Virginis	„	13 28 44·25	+0·60	13 28 19·87	−24·98
	η Ursæ maj.	„	13 43 2·58	−0·34	13 42 37·93	−24·31
	η Boötis	„	13 49 8·96	+0·31	13 48 44·44	−24·83
	α Boötis	W	14 10 22·80	−0·19	14 9 57·95	−24·66
	ϵ^2 Boötis	„	14 39 56·80	−0·36	14 39 31·90	−24·54
	α Libræ	„	14 44 22·24	+0·39	14 43 57·78	−24·85

Whence we have :—

	Lamp	Epoch by clock	Clock correction	Epoch by clock	Clock correction
		h. m.	s.	h. m.	s.
Jan. 30	E	13 40	−26·05	or 14 4	−26·05
	W	14 27	−26·04		
			Hourly rate in interval		+ 0·040
Jan. 31	W	4 20	−25·49	or 4 55	−25·46
	E	5 30	−25·43		
			Hourly rate in interval		+ 0·082
Jan. 31	E	13 13	−24·77	or 13 52	−24·73
	W	14 32	−24·68		
			Hourly rate in interval		+ 0·040

From the comparisons on p. 190, and the corrections to the sidereal clock, we obtain :—

Time by chronometer 411	Chronometer correction to Bombay mean time
h. m. s.	h. m. s.
6 0 15·00	+3 36 45·44
6 59 15·00	+3 36 45·00
	Hourly rate in interval −0·448 s.
h. m. s.	h. m. s.
14 35 45·00	+3 36 42·11
15 43 45·00	+3 36 41·70
	Hourly rate in interval −0·362 s.

These corrections and rates have been used to obtain the Bombay sidereal times in the table on p. 191.

The times of receiving and sending signals were all estimated by ear, the operator in both cases being Mr. F. Chambers.

COMPARISONS OF CHRONOMETER No. 411 WITH THE SIDEREAL CLOCK BY MEANS OF THE CHRONOGRAPH.

1875, JANUARY 31

Time by chronometer 411	Time by chrono-graph	Time by sidereal clock	Time by chronograph	Time by chronometer 411	Time by chrono-graph	Time by sidereal clock	Time by chronograph
h. m. s.	s.	h. m. s.	m. s.	h. m. s.	s.	h. m. s.	m. s.
6 0 0	10·50	6 19 50	0 50·94	6 59 0	18·79	7 19 30	1 29·92
2	12·50	52	52·95	2	20·80	32	31·90
4	14·54	54	54·88	4	22·80	34	33·92
6	16·50	56	56·89	6	24·79	36	35·86
8	18·50	19 58	0 58·93	8	26·80	38	37·85
10	20·51	20 0	1 0·89	10	28·80	40	39·90
12	22·50	2	2·90	12	30·79	42	41·88
14	24·50	4	4·88	14	32·80	44	43·96
16	26·50	6	6·89	16	34·80	46	45·83
18	28·50	8	8·83	18	36·80	48	47·85
20	30·58	10	10·80	20	38·80	50	49·84
22	32·54	12	12·80	22	40·80	52	51·83
24	34·50	14	14·87	24	42·80	54	53·85
26	36·54	16	16·79	26	44·80	56	55·82
28	38·50	18	18·79	28	46·80	19 58	57·81
6 0 30	40·55	20	20·79	6 59 30	48·80	7 20 0	1 59·75
...	...	22	22·81	...	...	...	...
...	...	24	24·80	...	...	...	...
...	...	26	26·80	...	...	...	...
...	...	28	28·83	...	...	...	...
...	...	6 20 30	1 30·88	...	...	...	...
[6 0 15·00]	[25·52]	[6 20 10·00]	[1 10·85]	[6 59 15·00]	[33·80]	[7 19 45·00]	[1 44·86]
14 35 30	0·76	14 56 40	0 40·46	15 43 30	11·61	16 5 0	1 0·68
32	2·78	42	42·46	32	13·60	2	2·62
34	4·75	44	44·50	34	15·60	4	4·60
36	6·75	46	46·49	36	17·60	6	6·65
38	8·70	48	48·48	38	19·59	8	8·68
40	10·74	50	50·60	40	21·59	10	10·60
42	12·72	52	52·53	42	23·56	12	12·69
44	14·73	54	54·59	44	25·59	14	14·62
46	16·76	56	56·50	46	27·58	16	16·60
48	18·71	56 58	0 58·44	48	29·59	18	18·66
50	20·72	57 0	1 0·48	50	31·59	20	20·58
52	22·71	2	2·47	52	33·59	22	22·54
54	24·70	4	4·50	54	35·60	16 5 24	1 24·58
56	26·74	6	6·50	56	37·58	...	...
35 58	28·74	8	8·40	43 58	39·54	...	...
14 36 0	30·74	10	10·30	15 44 0	41·54	...	...
...	...	12	12·35	...	...	...	...
...	...	14	14·35	...	...	...	...
...	...	16	16·40	...	...	...	...
...	...	18	18·40	...	...	...	...
...	...	20	20·40	...	...	...	...
...	...	14 57 22	1 22·35	...	...	...	...
[14 35 45·00]	[15·73]	[14 57 1·00]	[1 1·45]	[15 43 45·00]	[26·58]	[16 5 12·00]	[1 12·62]

The chronographic comparisons of the chronometer and sidereal clock were made by Mr. F. Chambers.

Operations at Bombay.

We now give the chronometer and Bombay sidereal times of despatch and receipt of signals at Bombay, and also the Aden sidereal times of the receipt and despatch of the same signals recorded at Aden (details of which will be found in Chapter XIII.), and lastly the resulting difference of meridians :—

1875, January 31

Set 1

Number of signal	Time by chronometer 411	Bombay sidereal time ; signals *received*	Corresponding Aden sidereal time ; signals *sent*	Resulting longitude, Bombay east of Aden
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	6 20 33·2	6 39 20·56	4 48 1·25	1 51 19·31
2	43·2	30·59	11·45	19·14
3	53·1	40·52	21·25	19·27
4	21 3·1	50·53	31·25	19·28
5	13·1	40 0·56	41·35	19·21
6	33·1	20·62	49 1·45	19·17
7	43·0	30·54	11·45	19·09
8	53·0	40·57	21·35	19·22
9	22 3·0	50·60	31·25	19·35
10	13·0	41 0·62	41·25	19·37
11	32·9	20·57	50 1·25	19·32
12	42·9	30·60	11·25	19·35
13	52·8	40·52	21·25	19·27
14	23 2·7	50·45	31·25	19·20
15	12·8	42 0·58	41·25	19·33
16	42·7	30·55	51 11·25	19·30
17	52·8	40·68	21·25	19·43
18	24 2·6	50·51	31·25	19·26
19	6 24 12·6	6 43 0·53	4 51 41·36	19·17

Set 2

Number of signal	Time by chronometer 411	Bombay sidereal time ; signals *sent*	Corresponding Aden sidereal time ; signals *received*	Resulting longitude, Bombay east of Aden
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	6 29 20·0	6 48 8·73	4 56 50·27	1 51 18·46
2	30·0	18·76	59·77	18·99
3	40·0	28·79	57 9·77	19·02
4	50·0	38·82	20·17	18·65
5	30 30·0	49 18·92	58 0·37	18·55
6	40·0	28·94	10·37	18·57
7	50·0	38·97	20·47	18·50
8	31 30·0	50 19·08	59 0·57	18·51
9	40·0	29·11	10·67	18·44
10	50·0	39·13	20·77	18·36
11	32 10·0	59·18	40·88	18·30
12	20·0	51 9·21	50·88	18·33
13	30·0	19·23	5 0 0·98	18·25
14	40·0	29·26	10·98	18·28
15	50·0	39·29	21·08	18·21
16	33 10·0	59·33	41·08	18·25
17	20·0	52 9·36	50·98	18·38
18	30·0	19·39	1 0·98	18·41
19	40·0	29·42	11·08	18·34
20	6 33 50·0	6 52 39·44	5 1 21·08	18·36

1875, JANUARY 31

SET 3

Number of signal	Time by chronometer 411	Bombay sidereal time ; signals *sent*	Corresponding Aden sidereal time ; signals *received*	Resulting longitude, Bombay east of Aden
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	6 36 10·0	6 54 59·81	5 3 41·19	1 51 18·62
2	20·0	55 9·83	51·29	18·54
3	30·0	19·86	4 1·39	18·47
4	40·0	29·89	11·39	18·50
5	50·0	39·92	21·39	18·53
6	37 10·0	59·96	41·39	18·57
7	20·0	56 9·99	51·29*	[18·70]
8	30·0	20·02	5 1·39	18·63
9	40·0	30·04	11·49	18·55
10	50·0	40·07	21·49	18·58
11	38 10·0	57 0·13	41·49	18·64
12	20·0	10·15	51·59	18·56
13	30·0	20·17	6 1·69	18·48
14	40·0	30·20	11·69	18·51
15	50·0	40·23	21·79	18·44
16	39 10·0	58 0·28	41·89	18·39
17	20·0	10·31	51·89	18·42
18	30·0	20·33	7 1·89	18·44
19	40·0	30·36	11·69	18·67
20	6 39 50·0	6 58 40·38	5 7 21·80	18·58

SET 4

Number of signal	Time by chronometer 411	Bombay sidereal time ; signals *received*	Corresponding Aden sidereal time ; signals *sent*	Resulting longitude, Bombay east of Aden
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	6 43 30·0	7 2 20·96	5 11 1·50	1 51 19·46
2	39·8	30·79	11·30	19·49
3	49·7	40·71	21·40	19·31
4	59·7	50·73	31·30	19·43
5	44 9·6	3 0·66	41·30	19·36
6	29·6	20·72	12 1·30	19·42
7	39·6	30·74	11·40	19·34
8	49·5	40·67	21·31	19·36
9	59·5	50·70	31·41	19·29
10	45 29·4	4 20·67	13 1·31	19·36
11	39·4	30·70	11·31	19·39
12	49·3	40·62	21·31	19·31
13	59·2	50·55	31·41	19·14
14	46 9·2	5 0·58	41·31	19·27
15	29·0	20·43	14 1·31	19·12
16	39·2	30·65	11·41	19·24
17	49·2	40·68	21·31	19·37
18	59·1	50·61	31·51	19·10
19	6 47 9·0	7 6 0·53	5 14 41·31	19·22

* This signal is marked uncertain at the Aden end ; rejected

1875, JANUARY 31

SET 5

Number of signal	Time by chronometer 411	Bombay sidereal time ; signals *received*	Corresponding Aden sidereal time ; signals *sent*	Resulting longitude ; Bombay east of Aden
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 43 15·0	15 3 21·71	13 12 2·47	1 51 19·24
2	24·8	31·53	12·27	19·26
3	34·9	41·66	22·27	19·39
4	44·9	51·69	32·37	19·32
5	55·0	4 1·81	42·27	19·54
6	44 15·0	21·87	13 2·27	19·60
7	25·0	31·90	12·37	19·53
8	34·9	41·82	22·27	19·55
9	44·8	51·75	32·27	19·48
10	54·8	5 1·77	42·27	19·50
11	45 14·7	21·72	14 2·37	19·35
12	34·7	41·78	22·27	19·51
13	54·5	6 1·63	42·27	19·36
14	46 14·6	21·79	15 2·27	19·52
15	24·6	31·81	12·27	19·54
16	34·6	41·84	22·27	19·57
17	44·6	51·86	32·27	19·59
18	14 46 54·6	15 7 1·89	13 15 42·27	19·62

SET 6

Number of signal	Time by chronometer 411	Bombay sidereal time ; signals *sent*	Corresponding Aden sidereal time ; signals *received*	Resulting longitude ; Bombay east of Aden
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 54 40·0	15 14 48·52	13 23 30·09	1 51 18·43
2	50·0	58·54	39·99	18·55
3	55 10·0	15 18·59	24 0·09	18·50
4	20·0	28·62	10·09	18·53
5	30·0	38·65	20·09	18·56
6	40·0	48·67	30·29	18·38
7	50·0	58·70	40·19	18·51
8	56 10·0	16 18·76	25 0·29	18·47
9	20·0	28·78	10·29	18·49
10	30·0	38·80	20·29	18·51
11	40·0	48·83	30·29	18·54
12	50·0	58·86	40·29	18·57
13	57 10·0	17 18·91	26 0·39	18·52
14	20·0	28·94	10·29	18·65
15	30·0	38·96	20·39	18·57
16	40·0	48·99	30·29	18·70
17	14 57 50·0	15 17 59·02	13 26 40·39	18·63

1875, JANUARY 31

SET 7

Number of signal	Time by chronometer 411	Bombay sidereal time; signals *sent*	Corresponding Aden sidereal time; signals *received*	Resulting longitude; Bombay east of Aden
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	15 4 10·0	15 24 20·02	13 33 1·51	1 51 18·51
2	20·0	30·05	11·51	18·54
3	30·0	40·07	21·41	18·66
4	40·0	50·10	31·41	18·69
5	50·0	25 0·12	41·51	18·61
6	5 10·0	20·17	34 1·61	18·56
7	20·0	30·20	11·61	18·59
8	30·0	40·23	21·61	18·62
9	40·0	50·26	31·71	18·55
10	50·0	26 0·28	41·71	18·57
11	6 10·0	20·34	35 1·61	18·73
12	20·0	30·36	11·71	18·65
13	30·0	40·38	21·81	18·57
14	50·0	27 0·44	41·61	18·83
15	7 10·0	20·49	36 2·01	18·48
16	20·0	30·52	12·01	18·51
17	30·0	40·55	22·01	18·54
18	40·0	50·58	32·11	18·47
19	15 7 50·0	15 28 0·60	13 36 41·81	18·79

SET 8

Number of signal	Time by chronometer 411	Bombay sidereal time; signals *received*	Corresponding Aden sidereal time; signals *sent*	Resulting longitude; Bombay east of Aden
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 59 12·2	15 19 21·43	13 28 2·30	1 51 19·13
2	22·3	31·56	12·30	19·26
3	32·3	41·59	22·30	19·29
4	42·3	51·62	32·30	19·32
5	52·1	20 1·43	42·20	19·23
6	15 0 12·1	21·49	29 2·40	19·09
7	22·3	31·72	12·30	19·42
8	32·2	41·64	22·30	19·34
9	42·1	51·57	32·30	19·27
10	52·1	21 1·60	42·30	19·30
11	1 12·1	21·65	30 2·50	19·15
12	22·0	31·58	12·30	19·28
13	32·1	41·70	22·30	19·40
14	42·1	51·72	32·30	19·42
15	52·0	22 1·65	42·30	19·35
16	2 12·0	21·71	31 2·20	19·51
17	22·0	31·73	12·30	19·43
18	32·0	41·76	22·30	19·46
19	41·9	51·69	32·30	19·39
20	15 2 51·9	15 23 1·72	13 31 42·30	19·42

Classifying the means of the several sets, we obtain :—

Difference of longitude by signals sent from Bombay and recorded at Aden.

Date	Set	Number of signals	Resulting longitude, Bombay east of Aden					
			h.	m.	s.	h.	m.	s.
1875, Jan. 31	2	20	1	51	18·458	1	51	18·496
„ „	3	19			18·533			
„ „	6	17	1	51	18·536	1	51	18·570
„ „	7	19			18·604			

Difference of longitude by signals sent from Aden and recorded at Bombay.

Date	Set	Number of signals	Resulting longitude, Bombay east of Aden					
			h.	m.	s.	h.	m.	s.
1875, Jan. 31	1	19	1	51	19·265	1	51	19·290
„ „	4	19			19·315			
„ „	5	18	1	51	19·471	1	51	19·397
„ „	8	20			19·323			

Combining these results, on the supposition that the current time is the same in both directions, we have :—

		h.	m.	s.		s.
Jan. 31	Bombay east of Aden	1	51	18·893	Current time	0·397
„	„ „			18·984	„ „	0·414

Therefore, taking a final mean :—

	h.	m.	s.
Bombay east of Aden	1	51	18·94

	s.
Current time	0·405

This result is of course subject to the difference of personal equation between the various operations in observing transits and recording signals.

The station at Bombay is defined by the meridian line of the transit instrument at Coluba Observatory.

CHAPTER XIII.

OPERATIONS AT ADEN.

Astronomical observations were made at Aden with the following objects :—

1. To determine the errors of the chronometers on their arrival from Mauritius.
2. To determine the rates of the chronometers while on board ship during the stay at Aden.
3. To determine the error of the sidereal chronometer used in the exchanges of telegraph longitude signals with Suez and Bombay.
4. To determine the errors of the chronometers before leaving Aden for Suez.

The 'Dupleix' reached Aden on the evening of January 20, and, as the night was clear, arrangements were made to determine time and compare the chronometers at once.

As the more portable and easily mounted instrument, it was resolved to use the small universal instrument by Repsold belonging to the Dutch party; indeed, in the darkness it would hardly have been safe to have attempted to land and mount the Troughton and Simms' altazimuth.

During the voyage Dr. Oudemans had convinced Mr. Gill of the excellence of this small instrument, whose circles are only six inches in diameter, the results obtained with it in time and latitude determinations proving beyond doubt that, at least in the hands of Dr. Oudemans or Mr. Soeters, all desirable accuracy could be obtained by its means.

This instrument, and the method of its use by Dr. Oudemans, require and deserve further description, and the results go to show that even with apparently inferior means results of high accuracy can be attained when all sources of systematic error are eliminated.

The instrument has two vertical circles and one horizontal circle. One of the vertical circles is used for setting only, while the other is finely divided and, as well as the horizontal circle, is read by two microscopes. One division of the micrometer-head corresponds to ten seconds of arc, permitting easy estimation to 1″ or even 0″·5.

The telescope is of the form known as a 'broken transit,' having a prism of total reflection in the cube of the axis, by which the cone of rays from the objective is bent at right angles, and so passes through one of the pivots of the horizontal axis perforated for the purpose. To this pivot are attached the wire frame and the eye-piece (power 35). The wire frame contains five webs for observation of vertical transits, and two webs at right angles to these, between which the transits should be made. The other pivot is also perforated, and the illumination of the webs is effected by allowing the light of a lamp to fall upon a piece of ground glass inserted in the pivot, a small right-angled prism cemented on the inclined back of the prism of total reflection rendering a small portion of the centre of the prism parallel, and giving a very perfect central illumination.

The instrument is placed, when in use, on a strong but light tripod. This tripod can be loaded with stones at the lower part to give increased stability.

To guard somewhat against change of level produced by the weight of the observer on the ground in the immediate neighbourhood of the instrument, Dr. Oudemans and Mr. Soeters always employed a kind of movable platform, consisting of three boards fitted together and forming a triangle round the stand of the instrument; and no doubt immunity from change of level which might be produced by the pressure of the observer's foot on the ground very near the legs of the tripod is, to some extent, thus secured.

In order to eliminate errors of run and errors of the micrometer screws (for very minute errors in these would produce considerable errors in time), the instrument is always set exactly at a full division of the circle, the screws therefore reading $0^r{\cdot}00$. The steps in observing an altitude for time in the most advantageous manner are :—

1. The instrument is directed a little above a star east of the meridian, or below a star to the west, and clamped at an even division when the micrometer screws read $0^r{\cdot}00$.
2. The level attached to the microscope arm is read.
3. The vertical transit of the star over the five wires is observed.
4. The microscope arm level is read a second time.
5. The microscopes of the vertical circle are each carefully read twice (these readings are of course very nearly $0^r{\cdot}00$).
6. The thermometer reading is recorded.
7. The instrument is reversed, and set, as before, at an even division in advance of the star, and the operations 1 to 6 are repeated.

The barometer is supposed to be read at the beginning and end of the night's work.

This constitutes a complete observation, in which errors of the micrometer screw, run, and zenith point are entirely eliminated, but the result for time is still affected by the systematic error due to flexure and division error of the instrument.

To eliminate both these errors it is only necessary to observe in the same way another star of equal and opposite hour angle and zenith distance, when all systematic error whatever entirely disappears from the mean result.

If the wire transits are symmetrical, the mean of the two observations of the same wire in reverse positions of the same set will be the same for each of the five wires. Thus if wires I. and II. are observed by one observer, and III. and IV. by another, in both positions of the instrument, the mean of the times of observation of wires I. and II. will differ from the mean of the times of III. and IV. by the difference of personal equation of the observers.

Mr. Soeters and Mr. Gill made a series of such observations, with the following result :—

$$\text{Gill} - \text{Soeters} \quad . \quad . \quad . \quad . \quad = -0^s{\cdot}26 \pm 0^s{\cdot}06 ;$$

i.e. Mr. Gill observes the seconds of transit over a wire $0^s{\cdot}26$ greater than Mr. Soeters.

Again, on January 28 the following alternate observations, unfortunately interrupted by clouds, were made with the altazimuth by Dr. Oudemans and Mr. Gill :—

	Seconds by Mr. Gill	Seconds by Dr. Oudemans	Gill – Oudemans
			s.
o^1 Eridani	49·10	48·94 (2 wires)	+0·16
ϵ Tauri	5·57	5·17 (1 wire ½ W.)	+0·40
α Tauri	19·58	19·48 (2 wires)	+0·10

Or, when applied to the chronometer corrections :—

$$\text{Gill} - \text{Oudemans} \quad . \quad . \quad . \quad . \quad = -0^s{\cdot}18$$

Time Determination, 1875, January 20.

Nearly symmetrical vertical transits of *α Canis minoris* and *α Arietis* were observed by Mr. Gill. The zenith distances are corrected for refraction. The observations, of which all the details will be found on p. 207, were made closely in accordance with the method just described. The latitude of the station is $+12^\circ\ 47'\ 22''{\cdot}1$ (Chap. XX.); the approximate longitude $2^h\ 59^m\ 56^s$ east of Greenwich.

Z.D. East	°	′	″		Time by chronometer Hohwü 502 h.	m.	s.
α Canis minoris	48	1	17·60	Wire IV.	9	5	49·05
				„ V.			49·15
	45	31	7·24	Wire IV.	9	16	5·00
				„ V.			5·20
	43	30	58·67	Wire IV.	9	24	18·65
				„ V.			18·65

Z.D. West	°	′	″		Time by chronometer Hohwü 502 h.	m.	s.
α Arietis	42	1	12·59	Wire IV.	9	37	49·20
				„ V.			48·90
	44	1	11·04	Wire IV.	9	46	30·85
				„ V.			31·12

Whence—

	Epoch by H. 502 h.	m.	Correction of H. 502 to Aden mean time h.	m.	s.
By α Canis minoris	9	5·8	−0	44	23·31
	9	16·1			23·16
	9	24·3			23·15
By α Arietis	9	37·8			23·35
	9	46·5			23·26

Or, taking the mean of east and west, we have—

h.	m.		h.	m.	s.
At 9	28·8	by Hohwü 502, correction =	−0	44	23·26

It afterwards proved a fortunate circumstance that this method of time determination had been adopted on January 20, for on landing the altazimuth on the following day it was found that the webs had been broken on the voyage between Mauritius and Aden; and it would have been impossible to have replaced them in time to secure observations on the same night.

On the following day Mr. Soeters kindly inserted in the altazimuth a very beautiful set of webs from a Dutch cocoon, and these were used without further accident during the rest of the expedition.

Time Determinations, 1875, January 25, 28, 29, and 31.

Observations were secured on the above dates by Mr. Gill, with much labour and difficulty, by transits in the vertical of the pole star.

The night of the 25th was very windy, and the observations on that account were not so satisfactory as could be desired.

No opportunity of observing occurred on the 26th and 27th, and, as the 'Dupleix' was to

sail on the morning of Monday, February 1 (civil reckoning), it became a matter of much anxiety to secure time determinations and exchanges with Suez before that day; otherwise a week must be lost till the cable would again be at our disposal.

The observing station at Aden on the outward journey having been selected near the telegraph office at Steamer Point, it was very disappointing upon arrival there on the return journey to find that the land line connecting the telegraph office with the shore end of the cable at Telegraph Bay had broken down,[1] and that it was necessary to go to Telegraph Bay (nearly two miles from Steamer Point) in order to exchange signals with Suez.

At first it was arranged to observe at both stations, and to determine the difference of longitude by transport of chronometers, and then from the 28th to the 31st to transfer the operations entirely to Telegraph Bay during the exchange of telegraphic signals with Suez.

A pillar was accordingly built at Telegraph Bay, and a 30-inch transit instrument by Troughton and Simms mounted and approximately adjusted on the 22nd, but it soon became evident, from the continuance of cloudy weather, that every opportunity for observation would be required for the necessary time determinations alone.

The question then arose, Is it better to secure a greater accuracy in the telegraphic longitude Suez-Aden, and leave for after determination the difference of longitude between Steamer Point and Telegraph Bay, or to retain the observing station at Steamer Point and transport the time obtained there by chronometers to Telegraph Bay?

Notwithstanding all the risks and difficulties attending the latter plan, it was resolved to adopt it, as promising a complete result.

A *gharrie*, or carriage, was employed to transport the chronometers between the stations. One chronometer was placed in a wooden case well stuffed with wool, and put on the seat of the carriage. The other two chronometers, in their leather cases, were always carried by Mr. Gill, one placed on the top of the other, and held by both hands to prevent the possibility of twist, which would cause the balances to swing above or below their normal arc. These precautions were entirely successful, no case of 'tripping' having occurred, nor any change of rate beyond what may be traced to temperature.

We now give a statement of the chronometer comparisons, which shows the steps taken to detect 'trip,' and also furnishes a general programme of the operations.

Comparisons of Chronometers at Aden.

All the following comparisons have been made by the method of coincident beats, excepting such as are marked 'Est.,' indicating that they have been made by simple estimation.

The estimated comparisons with single chronometers have been entirely neglected, or used only as checks in transferring time to the standard chronometer, excepting on January 20, when the estimations of the Dutch chronometers (made to $\frac{1}{20}$ of a *second* or $\frac{1}{10}$ of a *beat*) were taken into account, and when (36) was compared with a number of chronometers before and after the shore trip.

Chronometer 43 is regulated to sidereal time; all the others to mean time.

[1] The insulation had failed; this was a frequent source of trouble at Aden, no ordinary method of insulation proving efficient.

JANUARY 20.

Before going ashore.

(36) Est.	(35)	(43)	(36)	(43)	(35)
h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
4 0 0·0	3 53 5·6	3 39 22·0	4 1 57·0	3 43 30·0	3 59 10·0
	5·7	3 42 30·5	4 5 5·0		

Before observations: after arrival on shore.

Comparison with Dutch Chronometers.

Hohwü 514 Est. Hohwü 502	Hohwü 514 Est. (35)	Hohwü 514 (43)
h. m. s. h. m. s.	h. m. s. h. m. s.	h. m. s. h. m. s.
8 22 41·00 8 23 47·15	8 27 55·2 4 47 36·5	8 30 14·0 4 34 23·5

After observations.

Hohwü 514 Est. Hohwü 502	Hohwü 514 Est. (35)	Hohwü 514 (43)
h. m. s. h. m. s.	h. m. s. h. m. s.	h. m. s. h. m. s.
10 4 55·00 10 6 1·25	10 9 35·22 6 29 16·5	10 12 18·5 6 16 44·5

On arrival on board.

(43)	(36)	(43)	(35)	(36) Est.	(35)
h. m. s.	h. m. s.	h. m. s.	h. m. s	h. m. s.	h. m. s.
7 2 51·0	7 24 53·5	7 4 49·0	7 19 56·5	7 19 0·0	7 12 5·2
7 3 27·1 Est.	7 25 30·0	7 7 51·0	7 22 58·0		5·3

Chronometer 36 was then compared with all the chronometers (see Comparisons on the Return Journey, No. LI. p. 160).

JANUARY 25.

Comparisons to determine rate of 36.

Before going ashore.

(36) h. m. s.	(30) h. m. s. Est.
2 33 0·0	2 37 38·7
2 34 0·0	(32) 3 1 4·1 „
2 37 0·0	(34) 2 21 8·35 „
2 38 0·0	(37) 2 32 35·3 „
2 39 0·0	(42) 2 30 35·8 ,

After return on board.

(36) h. m. s.	(30) s. Est.	(32) s. „	(34) s. „	(37) s. „	(42) s. „
10 51 0·0	41·6	3·5	7·1	35·2	35·2
	41·7	3·6	7·2	35·3	35·1
	„	„	„	„	
10 46 0·0					

Before going ashore.

(43)	(35)	(43)	(36)
h. m. s.	h. m. s.	h. m. s.	h. m. s.
2 43 42·0	2 40 14·0	2 50 17·0	2 53 54·0
2 46 45·5	2 43 17·0	2 53 19·5	2 56 56·0

On arrival at Steamer Point before observations.

(43)	(35)
h. m. s.	h. m. s.
5 27 44·0	5 23 49·5
5 30 48·0	5 26 53·0

After the observations.

(43)	(35)
h. m. s.	h. m. s.
9 16 33·0	9 12 1·5
9 19 35·0	9 15 3·0

After return on board.

(43)	(35)	(43)	(36)
h. m. s.	h. m. s.	h. m. s.	h. m. s.
9 57 10·0	9 52 32·0	10 1 31·0	10 3 59·0

Estimations for check.

(35)			(36)		
h.	m.	s.	h.	m.	s.
10	0	0·0	10	7	6·7 } 6·6 }
10	3	53·2	10	11	0·0

Chronometer 36 was then compared with all the chronometers (see Comparisons, Return Journey, No. LVI.)

1875, JANUARY 28.

Comparisons to determine rate of 36.

Before going ashore.

(36)	h.	m.	s.		h.	m.	s.	
	2	31	0·0	(30)	2	36	3·0 } 3·0 }	Est.
	2	32	0·0	(32)	2	58	56·8 } 56·8 }	„
	2	34	0·0	(34)	2	18*	58·0 } 58·0 }	„
	2	35	0·0	(37)	2	29	35·0 } 35·1 }	„
	2	36	0·0	(42)	2	27	28·7 } 28·7 }	„
	2	40	0·0	(1)			36·6 } 36·6 }	„
	„			(2)			21·7 } 21·7 }	„
	„			(3)			42·3 } 42·3 }	„
	„			(4)			52·4 } 52·3 }	„
	„			(8)			43·7 } 43·7 }	„
	„			(9)			30·4 } 30·4 }	„

After return on board.

(36)	h.	m.	s.		s.	
	10	30	0·0	(30)	5·7 } 5·7 }	Est.
	„			(32)	56·2 } 56·2 }	„
	„			(34)	57·1 } 57·2 }	„
	10	25	0·0	(37)	35·1 } 35·2 }	„
	„			(42)	28·1 } 28·2 }	„
	9	46	0·0	(1)	36·0 } 36·0 }	„
	„			(2)	21·7 } 21·8 }	„
	„			(3)	43·0 } 43·1 }	„
	„			(4)	52·0 } 52·0 }	„
	„			(8)	43·6 } 43·6 }	„
	„			(9)	30·7 } 30·7 }	„

* Should be 17m.

Before going ashore.

(43)			(36)		
h.	m.	s.	h.	m.	s.
2	53	37·0	2	45	43·5
2	56	46·0	2	48	52·0
3	6	3·0	2	58	7·5
3	9	11·0	3	1	15·0

(43)			(35)		
h.	m.	s.	h.	m.	s.
2	58	26·5	2	43	20·0
3	1	30·0	2	46	23·0

(43)			(7)		
h.	m.	s.	h.	m.	s.
2	59	39·0	3	3	41·5
3	2	48·0	3	6	50·0

On arrival at Steamer Point, before observations.

(43)			(35)		
h.	m.	s.	h.	m.	s.
4	0	30·5	3	45	14·0
4	6	44·5	3	51	27·0

(43)			(7)		
h.	m.	s.	h.	m.	s.
4	2	50·5	4	6	43·0
4	9	4·5	4	12	56·0
4	12	21·0	4	16	12·0

The weather became cloudy half an hour after observing began.

After observations.

(43)			(35)		
h.	m.	s.	h.	m.	s.
5	39	34·0	5	24	1·5

(43)			(7)		
h.	m.	s.	h.	m.	s.
5	44	22·0	5	47	58·5

Went to Telegraph Bay, but found that Dr. Löw had not yet had time after arrival at Suez for the erection of instrument.

After return to Steamer Point.

(43)	(35)	(43)	(7)
h. m. s.	h. m. s.	h. m. s.	h. m. s.
7 19 15·0	7 3 26·5	7 22 50·0	7 26 11·0

Waited for cloud to clear, but no improvement took place.

After return on board.

(43)	(7)	(43)	(35)	(43)	(36)
h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
9 38 47·5	9 41 47·0	9 41 35·5	9 25 24·0	9 46 32·0	9 37 32·5
				9 49 36·0	9 40 36·0

Chronometer 36 was then compared with all the chronometers (see Comparisons, Return Journey, No. LIX.)

JANUARY 29.

Comparisons to determine rate of (36).

Before going ashore.

(36)	h.	m.	s.		h.	m.	s.	
	1	10	0·0	(30)	1	15	10·5 10·5	Est.
	1	11	0·0	(32)	1	37	54·6 54·7	„
	1	13	0·0	(34)	0	56	55·0	„
	1	15	0·0	(37)	1	9	35·0	„
	1	16	0·0	(42)	1	6*	26·5 26·5	„
	1	20	0·0	(1)			35·0 35·0	„
		„		(2)			22·4 22·3	„
		„		(3)			44·8 44·8	„
		„		(4)			51·2 51·1	„
		„		(8)			43·5 43·5	„
		„		(9)			31·2 31·2	„

After return on board.

(36)	h.	m.	s.		s.	
	16	35	0·0	(30)	15·6 15·5	Est.
		„		(32)	52·8 52·8	„
		„		(34)	52·9 52·8	„
		„		(37)	35·0 35·0	„
		„		(42)	24·8 24·9	„
	16	1	0·0	(1)	34·0 34·0	„
		„		(2)	22·8 22·8	„
		„		(3)	46·6 46·6	„
		„		(4)	50·5 50·4	„
		„		(8)	43·5 43·5	„
		„		(9)	31·6	„

* Should be 7m.

Before going ashore.

(43)	(36)	(43)	(35)	(43)	(7)
h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1 39 40·0	1 28 8·5	1 41 45·0	1 22 59·0	1 47 51·0	1 48 17·5
1 58 32·0	1 46 57·5	1 44 49·0	1 26 2·5	1 51 5·0	1 51 31·0
2 1 40·0	1 50 5·0			1 54 14·0	1 54 39·5

Two of the chronometers were conveyed to Telegraph Bay and compared.

(43)	(35)
h. m. s.	h. m. s.
4 35 1·0	4 15 47·0
4 38 3·5	4 18 49·0

An attempt was made to exchange signals with Suez, but, on account of some misunderstanding, it was not successful.

After return to Steamer Point, before observations.

(43)			(35)		
h.	m.	s.	h.	m.	s.
11	43	11·0	11	22	48·0
11	46	18·5	11	25	55·0

After the observations.

(43)			(35)			(43)			(7)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
14	52	17·0	14	31	23·5	15	4	3·0	15	2	23·5
14	58	37·0	14	37	42·5	15	7	16·0	15	5	36·0
15	1	35·0	14	40	40·0	15	10	30·0	15	8	49·5

After return on board.

(43)			(35)			(43)			(7)			(43)			(36)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
15	39	6·0	15	18	5·0	15	48	48·0	15	47	1·5	16	3	18·0	15	49	28·5
15	42	7·5	15	21	6·0	15	51	58·0	15	50	11·0	16	6	24·0	15	52	34·0
15	45	15·0	15	24	13·0	15	58	22·0	15	56	34·0	16	9	34·0	15	55	43·5

Chronometer 36 was then compared with all the chronometers (see Comparisons, Return Journey, LX.)

JANUARY 30.

Comparisons to determine rate of (36).

Before going ashore.

	h.	m.	s.		s.	
(36)	4	11	0	(30)	19·5 19·5	Est.
		,,		(32)	51·8 51·8	,,
		,,		(34)	51·1 51·1	,,
		,,		(37)	35·6 35·6	,,
		,,		(42)	23·7 23·7	,,

After return on board.

	h.	m.	s.		s.	
(36)	17	31	0	(30)	23·8 23·8	Est.
		,,		(32)	50·3 50·3	,,
		,,		(34)	49·6 49·6	,,
		,,		(37)	35·1 35·1	,,
		,,		(42)	22·2 22·2	,,

Went direct to Telegraph Bay, taking chronometers 36, 35, and 43 ashore. The arrangement was that both observers should go to their respective cable-houses at $8^h\ 30^m$ Aden mean time, and wait till the line was clear.

On arrival at Telegraph Bay.

(43)			(35)			(43)			(36)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
4	59	9·5	4	36	0·0	5	11	22·0	4	55	27·0
5	5	18·5	4	42	8·0	5	14	32·0	4	58	36·5
5	8	27·0	4	45	16·0	5	17	39·0	5	1	43·0

At $10^h\ 30^m$ the line was clear, but Dr. Löw, who was observing, was not informed of it, and the opportunity was lost.

After return to Steamer Point.

(43)			(35)			(43)			(36)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
8	48	54·0	8	25	7·5	8	59	48·0	8	43	16·5
8	55	3·0	8	31	15·5	9	2	59·0	8	46	27·0
8	58	8·0	8	34	20·0	9	6	7·0	8	49	34·5

Attempted observations, but, on account of clouds, nothing satisfactory could be done. The sky becoming totally obscured, compared :—

(43)			(35)			(43)			(36)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
13	36	29·0	13	11	56·0	13	39	59·5	13	22	43·0
						13	43	13·0	13	25	56·0
						13	46	22·5	13	29	5·0

Went to Telegraph Bay, and on arrival compared :—

(43)			(35)			(43)			(36)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
14	10	37·0	13	45	58·5	14	20	21·0	14	2	58·0
14	13	42·0	13	49	3·0	14	23	28·5	14	6	5·0
14	16	49·0	13	52	9·5	14	26	35·0	14	9	11·0

Signals were then exchanged with Suez.

After exchange of signals with Suez.

(43)			(35)			(43)			(36)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
15	59	43·0	15	34	47·0	16	7	6·0	15	49	26·0
16	2	50·0	15	37	53·5	16	10	12·0	15	52	31·5

After return on board.

(43)			(35)			(43)			(36)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
17	1	20·0	16	36	14·0	17	9	43·0	16	51	53·0
17	4	33·5	16	39	27·0	[17	12	52·0	16	55	1·0*]

[*] This comparison is $0^s{\cdot}5$ in error, as shown by the estimation (43) $17^h\ 58^m\ 57^s{\cdot}8$ = (36) $17^h\ 41^m\ 0^s{\cdot}0$. It has been rejected.

Chronometer 36 was then compared with all the chronometers (see Comparisons, Return Journey, No. LXI.)

JANUARY 31—1ST PART.

Comparisons to determine rate of (36).

Before going ashore.

	h.	m.	s.		s.	
(36)	2	39	0·0	(30)	26·9 26·8	Est.
	,,			(32)	49·5 49·5	,,
	,,			(34)	48·3 48·4	,,
	,,			(37)	35·1 35·2	,
	,,			(42)	21·1 21·1	,,

After return on board.

	h.	m.	s.		s.	
(36)	11	35	0·0	(30)	29·5 29·5	Est.
	,,			(32)	48·5 48·6	,,
	,,			(34)	47·2 47·2	,,
	,,			(37)	35·1 35·1	,,
	,,			(42)	20·1 20·1	,,

Before going ashore.

(43)			(36)			(43)			(35)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
3	8	38·5	2	49	13·0	3	14	15·0	2	47	30·5
3	11	46·0	2	52	20·0	3	17	24·0	2	50	39·0

Chronometers were conveyed to Steamer Point in the hope of getting observations, but the sky was clouded, and the time came for exchange of signals with Bombay, so the chronometers were conveyed to Telegraph Bay.

On arrival at Telegraph Bay.

(43)			(35)			(43)			(36)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
5	18	24·4	4	51	20·0	[5	26	15·0	5	6	26·5*]
5	21	27·0	4	54	22·0	5	29	24·0	5	9	36·0
5	24	36·5	4	57	31·0	5	32	32·0	5	12	43·5

Exchanged signals with Bombay.

After exchange of signals with Bombay.

(43)			(35)			(43)			(36)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
6	11	21·0	5	44	8·0	6	16	37·0	5	56	41·5
[6	14	18·5	5	47	15·0]*	[6	20	46·0	5	59	50·0*]

[*] These comparisons, being evidently wrong, have been rejected.

Exchanged signals with Suez.

After exchange of signals with Suez.

(43)			(36)			(43)			(35)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
7	25	31·5	7	5	25·0	7	32	6·0	7	4	40·0
7	28	39·0	7	8	32·0	7	35	12·5	7	7	46·0
						7	38	21·0	7	10	54·0

The chronometers were then conveyed back to Steamer Point.

On arrival at Steamer Point, before observations.

(43)			(35)			(43)			(36)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
7	59	50·5	7	32	20·0	8	9	28·5	7	49	15·0
8	2	58·0	7	35	27·0	8	12	37·0	7	52	23·0

After the observations.

(43)			(35)			(43)			(36)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
10	18	49·0	9	50	56·0	10	29	28·0	10	8	52·0
10	21	53·0	9	53	59·5	10	32	43·0	10	12	6·5
10	25	3·0	9	57	9·0	10	35	48·0	10	15	11·0

After return on board.

(43)			(35)			(43)			(36)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
11	11	35·0	10	43	33·5	11	22	48·0	11	2	3·5
11	14	44·0	10	46	42·0	11	25	55·0	11	5	10·0
11	17	50·5	10	49	48·0	11	29	5·0	11	8	19·5

Chronometer 36 was then compared with all the chronometers (see Comparisons, Return Journey, No. LXII.)

JANUARY 31—2ND PART.

Comparisons to determine rate of (36).

Before going ashore.

	h.	m.	s.		s.	
(36)	11	15	0·0	(1)	31·0	Est.
					31·1	
		,,		(2)	24·0	,,
					24·0	
		,,		(3)	51·5	,,
					51·5	
		,,		(4)	48·0	,,
					48·0	
		,,		(8)	43·0	,,
					43·1	
		,,		(9)	33·0	,,
					33·0	
	11	35	0·0	(30)	29·5	,,
					29·5	
		,,		(32)	48·5	,,
					48·6	
		,,		(34)	47·2	,,
					47·2	
		,,		(37)	35·1	,,
					35·1	
		,,		(42)	20·1	,,
					20·1	

After return on board.

	h.	m.	s.		s.	
(36)	15	50	0·0	(1)	30·8	Est.
		,,		(2)	(23·1)*	,,
		,,		(3)	52·0	,,
		,,		(4)	47·6	,,
		,,		(8)	43·1	,,
		,,		(9)	33·1	,,
	16	12	0·0	(30)	31·0	,,
		,,		(32)	47·8	,,
		,,		(34)	46·6	,,
		,,		(37)	35·1	,,
		,,		(42)	19·6	,,

* This comparison, being evidently wrong, has been rejected.

The comparisons of (43) with (35) and (36) just given were also used for this second time of going ashore.

Conveyed chronometers ashore, and waited some time at Steamer Point in the hope of getting observations, but clouds being persistent, conveyed chronometers to Telegraph Bay and awaited the time agreed upon for exchange of signals with Bombay.

Exchanged signals with Bombay.

After exchange of signals with Bombay.

(43)			(35)			(43)			(36)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
14	33	29·0	14	4	55·0	(15	8	5·0	14	47	45·0) †
14	39	42·0	14	11	7·0	15	17	30·0	14	56	8·0
						15	20	35·5	14	59	13·0
						15	23	43·0	15	2	20·0

† This comparison, being evidently wrong, has been rejected.

Exchanged signals with Suez.

After return on board.

(43)			(35)			(43)			(36)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
14	51	9·0	15	22	22·5	15	57	55·5	15	36	27·0
14	54	13·0	15	25	26·0	16	1	4·0	15	39	35·0
						16	4	7·5	15	42	38·0

Chronometer 36 was then compared with all the chronometers (see Comparisons, Return Journey, LXIII.)

1875, JANUARY 20.

The following observations were taken by Mr. Soeters and Mr. Gill with a Repsold Universal Instrument mounted on the pillar at Lord Lindsay's station. The instrument and method of observation have already been described on p. 197.

CHRONOMETER HOHWÜ 502. ONE PART OF THE LEVEL = 4″·72.

Name of star	Position of ocular	Observer	Chronometer times of transit over the wires				Level readings		Microscope-micrometer readings					
			I.	II.	III.	IV.								
			b.	h. m. b.	s.	h. m. s.	p.	p.	° ′ ″	° ′ ″				
a Canis min.	N	S	5·5	9 3 39·3	…	…	10·0	−11·8	48 30 138	48 20 404				
„ „	„	G	…	…	54·0	9 4 10·9			435	680				
a Canis min.	S	G	…	…	44·1	9 7 27·4	11·9	− 9·9	312 30 130	312 20 336				
„ „	„	S	69·9	9 8 36·0	…	…			420	610				
a Canis min.	N	S	38·1	9 13 71·6	…	…	9·6	−12·2	46 0 140	45 50 403				
„ „	„	G	…	…	10·0	9 14 27·0			433	674				
a Canis min.	S	G	…	…	0·0	9 17 43·4	11·3	−10·6	315 0 136	314 50 347				
„ „	„	S	102·0	9 18 68·8	…	…			430	624				
a Canis min.	N	S	64·8	9 21 98·5	…	…	9·4	−12·5	44 0 136	43 50 400				
„ „	„	G	…	…	23·3	9 22 40·2			430	674				
a Canis min.	S	G	…	…	14·0	9 25 57·1	11·6	−10·3	317 0 144	316 50 355				
„ „	„	S	9·9	9 26 95·7	…	…			138	630				
			s.	h. m. s.	b.	h. m. b.								
a Arietis	S	S	…	…	58·1	9 35 22·4	13·3	− 8·6	41 30 142	41 20 396				
„	„	G	23·9	9 36 5·9	…	…			434	670				
a Arietis	N	G	13·9	9 39 32·5	…	…	9·5	−12·4	317 30 137	317 20 347				
„	„	S	…	…	15·2	9 40 51·2			430	621				
a Arietis	S	S	…	…	22·9	9 43 107·0	13·0	− 9·0	43 30 130	43 20 389				
„	„	G	5·75	9 44 47·9	…	…			425	661				
a Arietis	N	G	56·5	9 48 13·8	…	…	9·7	−12·3	315 30 130	315 20 352				
„	„	S	…	…	100·1	9 49 15·8			422	626				

	mm.	mm.	mm.
Barometer, No. 1,088	= 767·25	− 0·4	= 766·85
Att. Thermometer	= 27°·4	−0°·9	= 26°·5 Centigrade
Ext. Thermometer	= 24°·2	−0°·6	= 23°·6 „

In the column 'Position of ocular,' N signifies North ; S signifies South.

In the column 'Observer,' S and G indicate respectively Mr. Soeters and Mr. Gill. The former observed to *beats* of chronometer ; the latter to seconds.

The results of these observations have been given on p. 198.

OBSERVATIONS OF TIME STARS IN THE VERTICAL OF A POLE STAR, TAKEN WITH THE TROUGHTON AND SIMMS ALTAZIMUTH. OBSERVERS, MR. GILL AND DR. OUDEMANS; CHRONOMETER 43.

Date, 1875	Pole star	Position of circle	Chronometer time of pole star on wire III.	Level readings	Time star	Chronometer times of transit over the wires					Level readings
						I.	II.	III.	IV.	V.	
			h. m. s.	E p. W p.		s.	s.	h. m. s.	s.	s.	E p. W p.
Jan. 25	*a* Ursæ min.	E	7 11 9·0	16·4 17·0 / 23·2 9·9	*γ* Geminorum	...	35·6	7 19 *21·9	8·0	54·2	14·8 18·4 / 23·8 9·8
	a Ursæ min.	W	7 29 44·0	19·5 14·0 / 11·2 22·0	*ε* Canis maj.	31·2	46·9	7 38 2·0	17·0	...	18·6 15·0 / 9·2 24·5
	,, ,,	,,	,,	,, ,,	*γ* Canis maj.	25·0	39·5	7 43 53·2	7·1	20·9	,, ,,
	a Ursæ min.	W	7 51 55·0	15·5 18·0 / 9·5 24·1	*δ* Geminorum †	38·5	53·5	8 2 7·8	22·1	36·2	11·0 22·8 / 18·2 15·9
	a Ursæ min.	E	8 13 0·0	19·3 14·3 / 9·5 24·0	[*α* Geminorum ‡	49·4	33·3	8 17 17·7	2·1	...	11·6 22·0 / 20·2 13·5]
	,, ,,	,,	,,	,, ,,	*α* Canis min.	59·9	45·9	8 20 32·5	19·4	6·0	,, ,,
	a Ursæ min.	W	8 30 28·0	13·0 20·6 / 24·4 9·5	6 Cancri	29·0	44·4	8 45 49·8	14·2	29·3	12·0 21·9 / 20·0 13·5
Jan. 28 §	*a* Ursæ min.	E	4 46 35·5	18·5 14·0 / 10·5 21·9	o^1 Eridani	(15·7)	(2·65)	4 52 59·8	36·1	22·3	19·1 13·8 / 10·8 22·2
	a Ursæ min.	W	5 4 11·0	10·2 22·6 / 20·1 12·7	*ε* Tauri	37·4	51·3	5 10 5·3	...	(33·1)	12·0 21·2 / 20·5 12·2
	,, ,,	,,	,,	,, ,,	*α* Tauri	(51·7)	(5·35)	5 17 19·4	33·0	47·3	10·1 23·0 / 20·8 12·3
Jan. 29	*a* Ursæ min.	W	12 9 51·0	20·5 12·8 / 10·0 23·2	*β* Leonis	35·2	49·3	12 31 3·1	16·8	30·9	19·2 14·3 / 11·5 21·9
	a Ursæ min.	E	12 39 44·0	21·2 12·3 / 13·3 20·0	*ε* Corvi	15·3	0·5	12 50 46·4	32·4	17·9	12·0 21·9 / 21·3 12·3
	,, ,,	,,	,,	,, ,,	*η* Virginis	47·0	...	13 1 20·0	7·0	53·8	12·0 21·8 / 21·6 12·0
	a Ursæ min.	W	13 13 53·0	22·0 11·8 / 12·1 21·5	*α* Canum ven.	29·7	47·3	13 39 4·4	21·0	38·35	12·0 21·8 / 20·8 12·9
	,, ,,	,,	,,	,, ,,	*θ* Virginis	56·1	9·9	13 51 23·3	36·5	49·4	,, ,,
	a Ursæ min.	E	14 1 8·0	12·2 21·2 / 22·8 10·9	*α* Virginis	19·1	5·1	14 6 51·9	38·2	25·0	12·7 21·0 / 22·0 11·4
	,, ,,	,,	,,	,,	*η* Ursæ maj.	32·9	11·7	14 30 51·4	31·0	10·0	22·5 11·2 / 13·9 19·6
Jan. 31	*a* Ursæ min.	W	8 32 58·0	22·0 11·7 / 10·1 23·7	6 Cancri	8·4	23·9	8 45 38·9	53·5	8·8	10·0 24·0 / 20·3 13·5
	a Ursæ min.	E	8 54 40·0	21·3 12·6 / 9·5 24·5	*β* Cancri	2·2	48·4	8 57 35·1	21·6	8·0	10·0 24·0 / 20·3 13·5
	,, ,,	,,	,,	,, ,,	d^1 Cancri	25·3	10·8	9 4 57·2	43·4	29·1	,, ,,
	a Ursæ min.	W	9 12 48·0	12·0 22·3 / 22·8 11·7	*γ* Cancri	38·0	52·7	9 25 6·9	21·0	35·5	11·5 22·7 / 23·3 11·1
	,, ,,	,,	,,	,, ,,	*ε* Hydræ	...	33·0	9 27 46·4	59·5	13·0	,, ,,
	,, ,,	,,	,,	,, ,,	*α* Cancri	18·6	...	9 39 46·4	...	13·3	,, ,,

* Minute supplied.

† Wind very high.

‡ Star double; not being separated, this observation has not been used.

§ January 28. The wires in parentheses ( ) were observed by Dr. Oudemans; they have only been used for personal equation; see p. 197.

From the foregoing observations, assuming the rate of the chronometer $+0^{s}\cdot138$ per hour throughout, we get :—

		h.	m.	s.
1875, Jan. 25	Epoch by chronometer	7	58·5	c = +0·066
„ 28	„	5	7	= +0·011
„ 29	„	13	0	= −0·158
„ 31	„	9	10	= −0·096

Date, 1875	Star	Position of circle	C	Concluded chronometer time of transit over wire III.			R.A. of star, including daily aberration			Rate of chronometer to epoch	t−m		Cc	Chronometer correction		
			s.	h.	m.	s.	h.	m.	s.	s.	m.	s.	s.	h.	m.	s.
Jan. 25	γ Geminorum	E	+0·974	7	19	21·77	6	30	30·60	+0·09	+0	22·61	+0·06	−0	48	28·41
	ε Canis maj.	W	−1·915	7	38	2·01	6	53	44·14	+0·05	−4	10·32	−0·13			28·27
	γ Canis maj.	„	−1·540	7	43	53·28	6	58	7·47	+0·03	−2	42·36	−0·10			28·24
	δ Geminorum	„	−0·899	8	2	7·76	7	12	40·79	−0·01	+0	58·09	−0·06			28·95
	α Canis min.	E	+1·135	8	20	32·61	7	32	46·65	−0·05	−0	42·43	+0·07			28·36
	6 Cancri	W	−0·826	8	45	59·49	7	55	51·87	−0·11	+1	39·10	−0·05			28·70
Jan. 28	o^1 Eridani	E	+1·354	4	52	49·10	4	5	46·44	+0·03	−1	16·45	+0·01	−0	48	19·07
	ε Tauri	W	−0·943	5	10	5·48	4	21	19·67	−0·01	+0	26·83	−0·01			19·00
	α Tauri	„	−0·978	5	17	19·52	4	28	45·56	−0·02	+0	14·86	−0·01			19·13
Jan. 29	β Leonis	W	−0·991	12	31	3·20	11	42	42·00	+0·07	+0	6·60	+0·16	−0	48	14·37
	ε Corvi	E	+1·728	12	50	46·36	12	3	42·51	+0·02	−1	10·12	−0·27			14·22
	η Virginis	„	+1·231	13	1	20·17	12	13	31·35	0·00	−0	25·19	−0·19			14·20
	α Canum ven.	W	−0·698	13	39	4·32	12	50	11·84	−0·09	+0	37·97	+0·11			14·49
	θ Virginis	„	−1·324	13	51	23·17	13	3	29·15	−0·12	−0	20·40	+0·21			14·33
	α Virginis	E	+1·441	14	6	51·72	13	18	36·83	−0·15	+0	0·49	−0·23			14·78
	η Ursæ maj.	„	+0·583	14	30	51·19	13	42	37·85	−0·21	−0	0·59	−0·09			14·23
Jan. 31	6 Cancri	W	−0·826	8	45	38·85	7	55	51·91	+0·06	+1	38·55	+0·08	−0	48	8·25
	β Cancri	E	+1·073	8	57	34·93	8	9	45·50	+0·03	−0	18·75	−0·10			8·25
	d^1 Cancri	„	+0·944	9	4	57·02	8	16	13·77	+0·01	+0	34·95	−0·09			8·38
	γ Cancri	W	−0·902	9	25	6·96	8	36	4·55	−0·03	+0	54·03	+0·09			8·32
	ε Hydræ	„	−1·115	9	27	46·37	8	40	10·69	−0·04	−0	32·71	+0·11			8·32
	α Cancri	„	−1·032	9	39	46·26	8	51	40·37	−0·07	−0	2·48	+0·10			8·34

Method of Reduction.

Having so large a number of chronometers, and so many accurate intercomparisons with a small number of time determinations, the problem is, how to combine all so as to yield the best results for the purpose in hand.

It is true, the apparent probable errors of the time determinations are quite within the limits of required accuracy, but there is always the possibility of some unknown systematic error, and observations made, as these were, under circumstances of extreme anxiety and fatigue, are open to the suspicion of being affected with an unknown and variable personality.

To deduce definitively the result of the time determinations, it is necessary to know accurately the rate of the observing chronometer during the observations, and in determining this we shall also find the ratio of the chronometers used to transport time between the ship, the observing station, and the telegraph office.

The observations give the following errors and approximate rates of the observing chronometer 43 :—

1875	Epoch by (43)	Correction to local sidereal time		Hourly rate
	h. m.	h. m. s.	h. m. s.	s.
Jan. 20 . . .	5 25		−0 48 49·59	+0·1716
„ 25	7 58·5	Circle E −0 48 28·385 „ W 28·535	−0 48 28·46	+0·1358
„ 28	5 7	Circle E −0 48 19·070 „ W 19·065	−0 48 19·07	+0·1470
„ 29	13 0	Circle E −0 48 14·358 „ W 14·397	−0 48 14·38	+0·1374
„ 31	9 10	Circle E −0 48 8·315 „ W 8·308	−0 48 8·31	

Using these corrections and rates, we obtain from the comparisons with (43), by coincident beats, the corrections for (36), (35), and (7) in local mean time.

Rotation No.	(36)		(35)		(7)	
Date, 1875	Epoch by (36)	Chronometer correction	Epoch by (35)	Chronometer correction	Epoch by (7)	Chronometer correction
	h. m.	h. m. s.	h. m.	h. m. s.	h. m.	h. m. s.
Jan. 20	4 3	+2 50 7·30	3 59	+2 57 1·64	...	...
	7 25	7·05	7 21	1·74	...	...
Jan. 25	2 55	+2 49 54·37	2 42	+2 57 0·44	...	...
	...	...	5 25	0·48	...	...
	...	...	9 14	0·58	...	...
	10 4	53·83	9 53	0·52	...	...
Jan. 28	2 53	+2 49 46·43	2 45	+2 56 58·65	3 5	+2 37 49·46
	...	...	3 48	58·63	4 12	49·23
	...	...	5 24	58·64	5 48	48·86
	...	...	7 3	58·54	7 26	48·46
	9 39	45·76	9 25	58·56	9 42	48·00
Jan. 29	1 42	+2 49 43·99	1 25	+2 56 58·20	1 51	+2 37 44·69
	...	...	4 17	58·22	...	...
	...	...	11 24	58·07	...	...
	...	...	14 37	58·04	15 6	42·13
	15 53	42·57	15 21	57·99	15 51	41·91
Jan. 30	4 59	+2 49 40·74	4 41	+2 56 57·23	...	...
	8 46	40·35	8 30	57·12	...	...
	13 26	40·08	13 12	57·16	...	...
	14 6	40·07	13 49	57·15	...	...
	15 51	39·83	15 36	57·01	...	...
	16 52	39·71	16 38	57·05	...	...
Jan. 31	2 51	+2 49 38·46	2 49	+2 56 56·55	...	...
	5 11	38·22	4 54	56·50	...	...
	5 57	38·09	5 44	56·44	...	...
	7 7	37·95	7 8	56·39	...	...
	7 51	37·86	7 34	56·41	...	...
	10 12	37·73	9 54	56·46	...	...
	11 5	37·62	10 47	56·43	...	...
	14 59	37·22	14 8	56·33	...	...
	15 40	37·18	15 24	56·28	...	...

Taking the means of the combined results of these corrections before and after observations, the approximate reductions to local mean time are :—

Rotation No.	(36)		(35)		(7)	
Date, 1875	Epoch by (36)	Chronometer correction	Epoch by (35)	Chronometer correction	Epoch by (7)	Chronometer correction
	h. m.	h. m. s.	h. m.	h. m. s.	h. m.	h. m. s.
Jan. 20	5 44	+2 50 7·18	5 40	+2 57 1·69	...	...
„ 25	6 30	2 49 54·10	6 48	2 57 0·50	...	...
„ 28	6 16	46·10	5 41	2 56 58·60	6 3	+2 37 48·80
„ 29	8 48	43·28	9 25	58·10	8 40	43·36
„ 31	9 23	37·78	9 6	56·42	...	...

Adopting these corrections, we deduce from the comparisons the following table of exceedingly approximate rates of the chronometers, usually compared with (36) before going ashore and after return on board :—

APPROXIMATE DAILY RATES OF STATIONARY CHRONOMETERS

(1)	(2)	(3)	(4)	(8)	(9)	(30)	(32)	(34)	(37)	(42)
s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
−1·04	−3·44	−5·32	−1·52	−2·51	−3·46	−10·57	−0·19	+0·67	−2·38	−0·22

This table enables us to determine the rates of the chronometers when ashore.

The standard chronometer 36 was in most cases compared with some or all of these chronometers before the travelling chronometers were taken ashore and immediately after their return ; thus the rate of the standard is determined independently by many different chronometers. The sidereal chronometer having been compared with the standard by coincident beats before and after transport to and from shore, its rate also becomes known during the same interval, and finally the comparison of the other travelling chronometers with the sidereal chronometer determines their rates.

It is obvious from the remarkable regularity of these rates (due to the uniformity of temperature) that no sensible systematic error will arise in this method of determining the rates of the travelling chronometers.

January 20.—The chronometer 43 was only on shore for a little over three hours. During the interval—

		s.
By comparison with (36) before and after shore-trip	*Hourly* rate of (43)	= +0·140
„ (43) „ „	„ (35)	= −0·003
(43) during shore-trip	„ (H. 514)	= −0·018
„ (H. 514) „	„ (H. 502)	= −0·076

January 25.—The standard chronometer 36 remained on board ; for its rate during the shore-trip of the chronometers 43 and 35 we have :—

	s.
By comparison with (30) . . . . . *Hourly* rate	= −0·086
(32)	·075
(34)	·118
(37)	·105
(42)	·088
By its own rate	·110
Hourly rate of (36)	−0·097

Then—

				s.
By comparison with	(36)	. . .	*Hourly* rate of (43) on shore	= +0·134
„	(43)		„ (35) „	= −0·009

January 28.—The standard chronometer 36 remained on board, and its rate during the shore-trip of the chronometers 43, 35, and 7 was as follows :—

		s.
By comparison with	(30)	*Hourly* rate = −0·102
	(32)	·083
	(34)	·079
	(37)	·087
	(42)	·079
	(1)	·128
	(2)	·136
	(3)	·117
	(4)	·113
	(8)	·118
	(9)	·101
	By its own rate	·109
	Hourly rate of (36)	−0·104 ± 0·004*

Then—

				s.
By comparison with	(36) . .	*Hourly* rate of (43) on shore		= +0·136
„	(43)	„	(35) „	= −0·021
„	(43)	„	(7) „	= −0·224

January 29.—The standard chronometer 36 remained on board; for its rate during the shore-trip of the chronometers 43, 35, and 7 we have :—

		s.
By comparison with	(30) . . .	*Hourly* rate = −0·113
	(32)	·128
	(34)	·112
	(37)	·099
	(42)	·117
	(1)	·111
	(2)	·113
	(3)	·099
	(4)	·111
	(8)	·105
	(9)	·117
	By its own rate	·110
	Hourly rate of (36)	−0·111

Then—

				s.
By comparison with	(36) . .	*Hourly* rate of (43) on shore		= +0·131
„	(43)	„	(35) „	= −0·025
„	(43)	„	(7) „	= −0·210

January 30.—The standard chronometer 36 was taken on shore : we find its rate during the interval :—

* It is to be observed that the probable error chiefly arises from errors of comparison, and not from errors in the rates of the compared chronometers, the comparisons having been made by estimation and not by coincidence, and these estimations only attempted to the nearest $0^s{\cdot}1$. The probable error of hourly rate as deduced by *one* chronometer comes out $\pm 0^s{\cdot}113$ in an interval of eight hours. If we suppose the *whole* of this error to be due to error of comparison, the probable error of the estimation of an interval is $\pm 0^s{\cdot}104$, and as this involves the combined error of two comparisons, the probable error of each comparison, consisting of two estimations, is—

$$\pm \frac{0^s{\cdot}104}{\sqrt{2}} = \pm 0^s{\cdot}073$$

This small probable error of comparison shows that there is but little room to suppose much variability in the rates of the chronometers.

		s.
By comparison with (30)	*Hourly* rate	= −0·118
(32)		·120
(34)		·085
(37)		·137
(42)		·122
By its own rate		·113
Hourly rate of (36)		−0·116

Then—

				s.
By comparison with (36) . . .	*Hourly* rate of (43)	on shore	=	+ 0·108
„ (43)	„ (35)	„	=	−0·044

January 31, 1st part.—The standard chronometer 36 was again taken on shore; its rate during the interval was as follows :—

		s.
By comparison with (30)	*Hourly* rate	= −0·144
(32)		·114
(34)		·101
(37)		·105
(42)		·121
By its own rate		·113
Hourly rate of (36)		−0·116

Then—

				s.
By comparison with (36) . . .	*Hourly* rate of (43)	on shore	=	+ 0·122
„ (43)	„ (35)	„	=	−0·030

January 31, 2nd part.—The standard chronometer 36 was taken on shore; its rate during the interval comes out :—

		s.
By comparison with (1)	*Hourly* rate	= −0·098
(2)		(·340*)
(3)		·113
(4)		·150
(8)		·094
(9)		·122
(30)		·116
(32)		·170
(34)		·102
(37)		·099
(42)		·117
By its own rate		·113
Hourly rate of (36)		−0·118

(*) Chronometer 2 has been rejected, as one comparison is evidently 1s in error.

Then—

				s.
By comparison with (36) . . .	*Hourly* rate of (43)	on shore	=	+ 0·116
„ (43)	„ (35)	„	=	−0·054

Combined Results of Time Determinations and Chronometer Transferences.

January 20.—From observations—

	h.	m.	h.	m.	s.
Correction for (43) to Aden sidereal time at	5	25 by (43) . .	−0	48	49·59
		Hourly rate . .			+ 0·140

and from comparisons with (43)—

	h. m.	h. m. s.
Correction for (36) to Aden mean time at	5 44 by (36) . . .	+2 50 7·18
	Hourly rate . .	−0·108

January 25.—From observations—

	h. m.	h. m. s.
Correction for (43) to Aden sidereal time at	7 58·5 by (43) . .	−0 48 28·46
	Hourly rate . .	+0·134

and from comparisons with (43) before and after observations—

	h. m.	h. m. s.
Correction for (35) to Aden mean time at	7 19 by (35) . .	+2 57 0·54
	Hourly rate . .	−0·009

and from comparisons after return on board—

	h. m.	h. m. s.
Correction for (43) to Aden sidereal time at	10 1 by (43)—	
	By chronometer 35 . .	−0 48 28·1
	By its own rate . . .	28·19
	Mean	−0 48 28·18

and—

	h. m.	h. m. s.
Correction for (36) to Aden mean time at	10 4 by (36) . . .	+2 49 53·80
	Hourly rate . .	−0·097

January 28.—From observations—

	h. m.	h. m. s.
Correction for (43) to Aden sidereal time at	5 7 by (43) . .	−0 48 19·07
	Hourly rate . .	+0·136

and from comparisons with (43) before and after observations—

	h. m.	h. m. s.
Correction for (35) to Aden mean time at	4 36 by (35) . . .	+2 56 58·64
	Hourly rate . .	−0·021
„ (7) „	5 0 by (7) . . .	+2 37 49·05
	Hourly rate . .	−0·224

and from comparisons before going ashore—

	h. m.	h. m. s.
Correction for (43) to Aden sidereal time at	3 1 by (43)—	
	By chronometer 35 . . .	−0 48 19
	By chronometer 7 . . .	19·34
	By its own rate . . .	19·36
	Mean	−0 48 19·35

and—

	h. m.	h. m. s.
Correction for (36) to Aden mean time at	2 53 by (36) . . .	+2 49 46·44
	Hourly rate . .	−0·104

and from comparisons after return on board—

	h. m.	h. m. s.
Correction for (43) to Aden sidereal time at	9 48 by (43)—	
	By chronometer 35 . .	−0 48 18·43
	By chronometer 7 . .	18·42
	By its own rate . . .	18·43
	Mean	−0 48 18·43

and—

	h. m.	h. m. s.
Correction for (36) to Aden mean time at	9 39 by (36) . . .	+2 49 45·74
	Hourly rate . .	−0·104

January 29.—From observations—

	h.	m.	h.	m.	s.
Correction for (43) to Aden sidereal time at	13	0 by (43)	−0	48	14·38
		Hourly rate			+0·131

and from comparisons with (43) before and after observations—

	h.	m.	h.	m.	s.
Correction for (35) to Aden mean time at	13	0 by (35)	+2	56	58·06
		Hourly rate			−0·025
„ (7) „	15	6 by (7)	+2	37	42·11
		Hourly rate			−0·210

and from comparisons after return on board—

	h.	m.	h.	m.	s.
Correction for (43) to Aden sidereal time at	16	6 by (43)—			
		By chronometer 35	−0	48	13·94
		By chronometer 7			13·90
		By its own rate			13·97
		Mean	−0	48	13·94

and—

	h.	m.	h.	m.	s.
Correction for (36) to Aden mean time at	15	53 by (36)	+2	49	42·57
		Hourly rate			−0·111

January 31.—From observations—

	h.	m.	h.	m.	s.
Correction for (43) to Aden sidereal time at	9	10 by (43)	−0	48	8·31
		Hourly rate			+0·119

and from comparisons with (43) before and after observations—

	h.	m.	h.	m.	s.
Correction for (35) to Aden mean time at	8	44 by (35)	+2	56	56·44
		Hourly rate			−0·041
„ (36) „	9	1 by (36)	+2	49	37·79
		Hourly rate			−0·117

and from comparisons after return on board—

	h.	m.	h.	m.	s.
Correction for (43) to Aden sidereal time at	11	26 by (43)—			
		By chronometer 35	−0	48	8·08
		By chronometer 36			8·07
		By its own rate			8·04
		Mean	−0	48	8·06

and—

	h.	m.	h.	m.	s.
Correction for (36) to Aden mean time at	11	5 by (36)	+2	49	37·56
		Hourly rate			−0·117

In this way we obtain the subjoined table of the errors of (36) about the time of its comparison with the other chronometers on board :—

Date, 1875	Epoch by (36)	Definitive correction for (36) to Aden mean time	Daily rate at epoch	Hourly rate at epoch
	h. m.	h. m. s.	s.	s.
Jan. 20	5 44	+2 50 7·18	−2·59	−0·108
25	10 4	2 49 53·80	−2·33	−0·097
28	9 39	45·74	−2·50	−0·104
29	15 53	42·57	−2·66	−0·111
31	11 5	37·56	−2·81	−0·117

We are now in a position to find the errors of all the chronometers at each of these times of comparison with the standard.

COMPARISONS OF CHRONOMETERS WITH THE STANDARD CHRONOMETER 36.

Rotation No.	1875, JANUARY 20		1875, JANUARY 31		Rotation No.	1875, JANUARY 20		1875, JANUARY 31	
	Epoch by chronometer 36	Seconds of compared chronometer	Epoch by chronometer 36	Seconds of compared chronometer		Epoch by chronometer 36	Seconds of compared chronometer	Epoch by chronometer 36	Seconds of compared chronometer
	h. m. s.	s.	h. m. s.	s.		h. m. s.	s.	h. m. s.	s.
1	7 39 0	48·9	11 15 0	31·05	28	7 59 0	53·0	11 28 0	20·6
2	,,	14·0	,,	24·0	29	,,	39·05	,,	10·15
3	,,	21·6	,,	51·5	30	8 7 0	1·1	11 35 0	29·5
4	,,	0·25	,,	48·0	31	8 13 0	12·6	11 43 0	16·3
7	,,	38·0	,,	4·15	32	8 7 0	15·6	11 35 0	48·55
8	,,	44·6	,,	43·05	33	,,	51·45	,,	21·05
9	,,	23·8	,,	33·0	34	,,	24·1	,,	47·2
10	,,	53·6	,,	9·05	35	,,	5·2	...	...
11	,,	51·5	,,	52·5	36	...	...	...	...
12	7 49 0	9·3	11 21 0	35·6	37	8 7 0	38·05	11 35 0	35·1
13	,,	15·5	,,	59·5	38	8 13 0	14·5	11 41 0	34·8
14	,,	10·6	,,	44·5	39	,,	4·45	,,	18·1
15	,,	21·2	,,	14·2	40	,,	54·1	,,	15·8
16	,,	31·0	,,	8·15	42	8 7 0	47·0	11 35 0	20·1
17	,,	4·55	,,	22·3	43	...	...	...	...
18	,,	18·2	,,	18·15	44	8 22 0	37·5	11 48 0	36·0
19	,,	9·65	,,	28·0	45	,,	26·4	,,	55·0
20	,,	7·3	,,	13·05	46	,,	25·0	,,	33·75
21	7 59 0	0·0	11 28 0	10·5	47	,,	32·5	,,	55·0
22	,,	41·6	,,	55·5	48	,,	0·0	,,	56·6
23	,,	9·55	,,	10·65	49	,,	10·6	,,	33·1
24	,,	18·8	,,	22·0	50	,,	31·6	,,	16·8
25	,,	11·75	,,	28·55	51	,,	10·6	,,	36·1
26	,,	56·5	,,	13·8	52	,,	19·1	,,	29·6
27	,,	22·5	,,	32·6					

The next table (in which the corrections for chronometer 36 have been interpolated) contains the comparisons of the chronometrical thermometer with the standard chronometer 36, the corresponding *daily* rates of the former, and the deduced temperatures :—

Date, 1875	Time by chronometer 36	Aden mean time	Time by chronometrical thermometer	Correction of chronometrical thermometer	*Daily* rate of chronometrical thermometer	Deduced temperature
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	s.	s.
Jan. 19	21 26 0	24 16 8·1	16 13 36·3	+8 2 31·8	+118·4	84·2 F.
20	22 17 0	25 7 5·4	17 2* 31·0	4 34·4	+ 92·6	80·0
21	23 12 0	26 2 2·6	17 55† 52·1	6 10·5	+ 97·4	80·8
22	18 43 0	21 33 0·5	13 25 30·8	7 29·7	+ 84·7	78·8
24	21 51 0	24 40 54·8	16 30 24·5	10 30·3	+ 77·2	77·6
26	21 9 0	23 58 49·6	15 45‡ 47·1	13 2·5	+ 84·6	78·7
27	22 18 0	25 7 46·9	16 53 15·8	14 31·1	+ 92·5	80·0
29	16 38 0	19 27 42·2	11 10 28·0	17 14·2	+ 88·5	79·4
30	17 34 0	20 23 39·5	12 4 53·4	18 46·1	+ 90·2	79·6
31	11 38 0	14 27 37·5	6 7 43·5	19 54·0	+ 97·4	80·8
Feb. 1	21 19 0	24 8 33·8	15 46 23·1	22 10·7		

* Hour and minute supplied. † 5^m in original. ‡ 15^m in original.

From the general comparisons of chronometers and these temperatures we get the following table of corrections of all the chronometers, and also the corresponding values of r and R :—

Rotation No. of chronometer compared	JANUARY 20		JANUARY 31		Interval by (36)	Compared chronometer's loss in interval	r	Correction for temperature	R
	Epoch by (36)	Chronometer correction to Aden mean time	Epoch by (36)	Chronometer correction to Aden mean time					
	h. m.	h. m. s.	h. m.	h. m. s.	d.	s.	s.	s.	s.
1	7 39	+2 53 18·07	11 15	+2 53 6·49	11·150	− 11·58	− 1·039	−0·246	− 1·285
2	,,	2 40 52·97	,,	2 40 13·54	,,	− 39·43	− 3·536	−0·037	− 3·573
3	,,	2 39 45·37	,,	2 38 46·04	,,	− 59·33	− 5·321	−0·060	− 5·381
4	,,	2 48 6·72	,,	2 47 49·54	,,	− 17·18	− 1·541	−0·734	− 2·275
7	,,	2 38 28·97	,,	2 37 33·39	,,	− 55·58	− 4·985	−0·131	− 5·116
8	,,	2 50 22·37	,,	2 49 54·49	,,	− 27·88	− 2·500	−0·177	− 2·677
9	,,	2 47 43·17	,,	2 47 4·54	,,	− 38·63	− 3·465	−0·345	− 3·810
10	,,	2 43 13·37	,,	2 42 28·49	,,	− 44·88	− 4·025	−0·114	− 4·139
11	,,	2 32 15·47	,,	2 30 45·04	,,	− 90·43	− 8·110	−0·051	− 8·161
12	7 49	3 1 57·66	11 21	3 2 1·93	11·147	+ 4·27	+ 0·383	−0·475	− 0·092
13	,,	2 58 51·46	,,	2 58 38·03	,,	− 13·43	− 1·205	−0·003	− 1·208
14	,,	2 57 56·36	,,	2 57 53·03	,,	− 3·33	− 0·299	−0·232	− 0·531
15	,,	2 57 45·76	,,	2 57 23·33	,,	− 22·43	− 2·012	−0·032	− 2·044
16	,,	2 53 35·96	,,	2 53 29·38	,,	− 6·58	− 0·590	−0·343	− 0·933
17	,,	2 39 2·41	,,	2 38 15·23	,,	− 47·18	− 4·233	−0·252	− 4·485
18	,,	2 41 48·76	,,	2 41 19·38	,,	− 29·38	− 2·636	−0·194	− 2·830
19	,,	3 0 57·31	,,	3 1 9·53	,,	+ 12·22	+ 1·096	−0·124	+ 0·972
20	,,	2 34 59·66	,,	2 33 24·48	,,	− 95·18	− 8·539	...	− 8·539
21	7 59	2 49 6·94	11 28	2 48 27·01	11·145	− 39·93	− 3·583	...	− 3·583
22	,,	2 54 25·34	,,	2 54 42·01	,,	+ 16·67	+ 1·496	−1·221	+ 0·275
23	,,	2 50 57·39	,,	2 50 26·86	,,	− 30·53	− 2·739	−1·277	− 4·016
24	,,	2 47 48·14	,,	2 47 15·51	,,	− 32·63	− 2·928	−0·016	− 2·944
25	,,	2 48 55·19	,,	2 48 8·96	,,	− 46·23	− 4·148	−0·208	− 4·356
26	,,	3 15 10·44	,,	3 15 23·71	,,	+ 13·27	+ 1·191	−0·932	+ 0·259
27	,,	3 14 44·44	,,	3 15 4·91	,,	+ 20·47	+ 1·837	−0·382	+ 1·455
28	,,	2 59 13·94	,,	2 59 16·91	,,	+ 2·97	+ 0·266	−0·517	− 0·251
29	,,	3 4 27·89	,,	3 4 27·36	,,	− 0·53	− 0·048	...	− 0·048
30	8 7	2 46 5·82	11 35	2 44 8·00	11·144	−117·82	−10·573	−0·246	−10·819
31	8 13	3 0 54·31	11 43	3 1 21·19	11·146	+ 26·88	+ 2·412	−0·580	+ 1·832
32	,,	2 22 51·32	11 35	2 22 48·95	11·144	− 2·37	− 0·213	...	− 0·213
33	,,	2 56 15·47	,,	2 55 16·45	,,	− 59·02	− 5·296	−0·682	− 5·978
34	,,	3 5 42·82	,,	3 5 50·30	,,	+ 7·48	+ 0·671	−0·138	+ 0·533
35	,,	2 57 1·72	,,	2 56 56·26	,,	− 5·46	− 0·487	−0·024	− 0·511
37	,,	2 55 28·87	,,	2 55 2·40	,,	− 26·47	− 2·375	−0·373	− 2·748
38	,,	2 35 52·41	11 41	2 35 2·69	,,	− 49·72	− 4·462	−0·413	− 4·875
39	,,	2 22 2·46	,,	2 20 19·39	,,	−103·07	− 9·249	−0·235	− 9·484
40	,,	2 46 12·81	,,	2 45 21·69	,,	− 51·12	− 4·587	−0·190	− 4·777
42	8 7	2 58 19·92	11 35	2 58 17·40	,,	− 2·52	− 0·226	0·000	− 0·226
44	8 22	4 54 29·40	11 48	4 54 1·48	11·143	− 27·92	− 2·506	−0·032	− 2·538
45	,,	3 9 40·50	,,	3 9 42·48	,,	+ 1·98	+ 0·178	−0·151	+ 0·027
46	,,	4 49 41·90	,,	4 48 3·73	,,	− 98·17	− 8·810	...	− 8·810
47	,,	+3 56 34·40	,,	+3 58 42·48	,,	+128·08	+11·494	−1·694	+ 9·800
48	,,	−1 50 53·10	,,	−1 50 19·12	,,	+ 33·98	+ 3·049	−1·185	+ 1·864
49	,,	+2 45 56·30	,,	+2 45 4·38	,,	− 51·92	− 4·659	−0·185	− 4·844
50	,,	3 1 35·30	,,	3 1 20·68	,,	− 14·62	− 1·312	−· 542	− 1·854
51	,,	3 2 56·30	,,	3 3 1·38	,,	+ 5·08	+ 0·456	−0·333	+ 0·123
52	,,	+3 18 47·80	,,	+3 18 57·88	,,	+ 10·08	+ 0·905	...	+ 0·905
36	5 44	+2 50 7·18	11 5	+2 49 37·56	11·223	− 29·62	− 2·639	−0·025	− 2·664
43*	5 25	−0 49 49·59	9 10	−0 48 8·31	11·156	+ 41·27	+ 3·700	−0·438	+ 3·262

* Chronometer 43 is sidereal ; the times given are by itself, and the corrections are on sidereal time.

COMPARISON OF STATIONARY CHRONOMETERS WITH THE STANDARD CHRONOMETER 36.

Rotation No.	1875, JANUARY 29		1875, JANUARY 30		1875, JANUARY 31	
	Time by chronometer 36	Seconds of compared chronometer	Time by chronometer 36	Seconds of compared chronometer	Time by chronometer 36	Seconds of compared chronometer
	h. m. s.	s.	h. m. s.	s.	h. m. s.	s.
1	16 1 0	34·0	13 38 0	32·45	15 50 0	30·8
2	,,	22·8	,,	23·6	,,	24·1†
3	,,	46·6	,,	49·6	,,	52·0
4	,,	50·45	,,	49·1	,,	47·6
8	,,	43·5	,,	43·3	,,	43·1
9	,,	31·6	,,	32·5	,,	33·1
10	,,	6·4	,,	8·0	,,	9·6
11	,,	42·6*	,,	48·5	,,	53·5
12	16 11 0	41·25	13 46 0	38·3	15 55 0	35·0
13	,,	1·75	,,	0·55	,,	59·4
14	,,	48·55	,,	46·6	,,	43·8
15	,,	15·65	,,	15·05	,,	13·9
16	,,	11·95	,,	10·0	,,	7·8
17	,,	19·6	,,	21·5	,,	22·6
18	,,	18·5	,,	18·5	,,	18·2
19	,,	34·5	,,	30·85	,,	27·4
20	,,	2·05	,,	8·6	,,	14·4
21	16 23 0	8·8	13 56 0	10·0	16 5 0	10·8
22	,,	2·55	,,	58·5	,,	54·6
23	,,	10·8	,,	10·8	,,	10·8
24	,,	20·75	,,	21·7	,,	21·9
25	,,	26·15	,,	27·55	,,	29·0
26	,,	21·1	,,	16·55	,,	13·0
27	,,	40·0	,,	35·65	,,	31·8
28	,,	27·15	,,	23·1	,,	20·0
29	,,	15·55	,,	12·55	,,	9·6
30	16 35 0	15·55	14 5 0	23·8	16 15 0	31·0
31	,,	25·5	14 9 0	20·1	16 12 0	15·4
32	,,	52·8	14 5 0	50·3	,,	47·8
33	,,	18·7	,,	20·35	,,	21·0
34	,,	52·85	,,	49·6	,,	46·6
37	,,	35·0	,,	35·1	16 17 0	35·1
38	16 43 0	31·6	14 12 0	33·5	,,	35·0
39	16 45 0	6·05	14 13 0	13·1	,,	19·3
40	,,	13·0	,,	14·8	,,	16·0
42	,,	24·85	14 10 0	22·2	16 12 0	19·6
44	16 52 0	36·5	14 20 0	36·15	16 27 0	35·8
45	,,	0·65	,,	57·35	,,	54·5
46	,,	23·8	,,	29·9	,,	34·8
47	,,	20·2	,,	5·75	,,	52·5
48	,,	7·25	,,	0·9	,,	55·5
49	,,	29·75	,,	31·95	,,	33·6
50	,,	19·15	,,	18·0	,,	16·5
51	,,	42·0	,,	38·65	,,	35·5
52	,,	46·1	,,	42·5	,,	39·0

* $47^{s}\cdot6$ in original.

† $23^{s}\cdot1$ in original.

From the preceding comparisons we find, first of all, the corrections of the compared chronometers on January 29 from the previously determined correction of chronometer 36; and then, by interpolating in the one case between these and the corrections on January 31 (p. 217),

and extrapolating by the rates given on the same page in the other case, we get the corrections to Aden mean time of chronometer 36 on January 30 and 31 by each chronometer.

Rotation No.	Chronometer corrections on January 29, 1875	Interpolated correction of chronometer 36 on January 30, at $17^h\ 20^m$ by chronometer 36	Extrapolated correction of chronometer 36 on January 31, at $16^h\ 0^m$ by chronometer 36
	h. m. s.	h. m. s.	h. m. s.
1	+2 53 8·56	+2 49 39·79	+2 49 37·08
2	2 40 19·76	39·71	36·94
3	2 38 55·96	39·81	37·00
4	2 47 52·11	39·67	36·83
8	2 49 59·06	39·68	37·09
9	2 47 10·96	39·72	36·96
10	2 42 36·16	39·72	37·30
11	2 30 59·96	39·81	36·97
12	3 2 1·29	39·94	36·99
13	2 58 40·79	39·77	37·19
14	2 57 53·99	40·05	36·76
15	2 57 26·89	39·86	36·84
16	2 53 30·59	39·88	37·06
17	2 38 22·94	39·97	37·02
18	2 41 24·04	39·82	37·07
19	3 1 8·04	39·77	37·13
20	2 33 40·49	39·87	37·25
21	2 48 33·71	39·86	37·13
22	2 54 39·96	39·70	36·95
23	2 50 31·71	39·70	37·15
24	2 47 21·76	39·92	36·86
25	2 48 16·36	39·63	37·17
26	3 15 21·41	39·28	36·96
27	3 15 2·51	39·62	37·07
28	2 59 15·36	39·27	36·97
29	3 4 26·96	39·70	36·96
30	2 44 26·94	39·59	36·98
31	3 1 16·99	39·57	37·06
32	2 22 49·69	39·61	36·73
33	2 55 23·79	39·73	36·46
34	3 5 49·64	39·69	37·05
37	2 55 7·49	39·72	37·06
38	2 35 10·88	39·68	36·86
39	2 20 36·42	39·71	36·94
40	2 45 29·47	39·76	36·84
42	2 58 17·62	39·70	36·98
44	4 54 5·96	39·56	36·84
45	3 9 41·81	39·57	37·06
46	4 48 18·66	39·88	36·87
47	+3 58 22·26	39·82	37·27
48	−1 50 24·79	39·43	37·03
49	+2 45 12·71	39·87	37·13
50	3 1 23·31	39·86	36·98
51	3 3 0·46	39·69	37·02
52	3 18 56·36	39·80	37·11

We have now all the data for computing definitively the errors of the chronometers when ashore on January 30 and 31—the nights on which signals were exchanged with Suez and Bombay. Taking the means of the corrections for (36), and tabulating the results, we obtain the three subjoined values, from which the error of (36) can be computed for any instant during each trip on shore.

Definitive corrections and rates of chronometers *at the times of shore-trips* at Aden in connection with the exchange of signals with Suez and Bombay :—

Chronometer 36.

		Correction to Aden mean time	Hourly rate
		h. m. s.	s.
Jan. 30, . . . at 17	20 by (36)	+2 49 39·73	−0·116
„ 31, 1st trip, at 11	5 by (36)	37·56	−0·117
„ 31, 2nd trip, at 16	0 by (36)	37·00	−0·117

And thence, from comparisons of (36) with (43) by coincident beats about the same epochs, we obtain the corrections of chronometer 43 :—

Chronometer 43.

		Correction to Aden sidereal time	Hourly rate
		h. m. s.	s.
Jan. 30, . . . at 17	10 by (43) . . .	−0 48 10·44	+0·108
„ 31, 1st trip, at 11	26 by (43)	8·06	+0·122
„ 31, 2nd trip, at 16	1 by (43)	7·51	+0·116

And lastly, from comparisons of (43) with (35) by coincident beats, we obtain the following corrections of chronometer 35 :—

Chronometer 35.

		Correction to Aden mean time	Hourly rate
		h. m. s.	s.
Jan. 30, . . . at 16	38 by (35)	+2 56 57·13	−0·044
„ 31, 1st trip, at 10	47 by (35)	56·38	−0·030
„ 31, 2nd trip, at 15	24 by (35)	56·14	−0·054

We can now employ these corrections and rates to find those of chronometer 43 by each of the three chronometers :—

			Correction to Aden sidereal time
		h. m.	h. m. s.
Jan. 30.	By comparison with (35) at 14	14 by (43)	−0 48 10·81
	By comparison with (36) at 14	23 by (43)	10·86
	By its own rate . . . at 14	0 by (43)	10·78
Jan. 30.	By comparison with (35) at 16	1 by (43)	−0 48 10·50
	By comparison with (36) at 16	9 by (43)	10·58
	By its own rate . . . at 16	10 by (43)	10·55
Jan. 31.	By comparison with (35) at 5	21 by (43)	−0 48 8·77
	By comparison with (36) at 5	31 by (43)	8·78
	By its own rate . . . at 5	26 by (43)	8·79
Jan. 31.	By comparison with (35) at 6	11 by (43)	−0 48 8·63
	By comparison with (36) at 6	17 by (43)	8·64
	By its own rate . . . at 6	26 by (43)	8·67
Jan. 31.	By comparison with (35) at 7	35 by (43)	−0 48 8·43
	By comparison with (36) at 7	27 by (43)	8·48
	By its own rate . . . at 7	26 by (43)	8·55
Jan. 31.	By comparison with (35) at 14	37 by (43)	−0 48 7·68
	By comparison with (36) at 15	21 by (43)	7·56
	By its own rate . . . at 14	59 by (43)	7·63

The means of these now give the definitive corrections of chronometer 43 at the times when signals were exchanged with Suez and Bombay :—

Definitive corrections of chronometer 43 *at Telegraph Office, Telegraph Bay, Aden, on sidereal time of Steamer Point, Aden.*

		Correction to Aden sidereal time	Hourly rate
h. m.		h. m. s.	s.
Jan. 30, at 14	12 by (43)	−0 48 10·82	
			+0·143
„ at 16	7 by (43)	10·54	
			...
Jan. 31, at 5	26 by (43)	8·78	
			+0·153
„ at 6	18 by (43)	8·65	
			+0·135
„ at 7	29 by (43)	8·49	
			+0·116
„ at 14	59 by (43)	7·62	

These corrections and rates have been used to obtain the Aden sidereal times from the chronometer times in the ensuing tables.

Signals sent to and received from Bombay.

The following are the chronometer times of despatch and receipt of signals to and from Bombay. In anticipation of the data from which they are derived, the sidereal times have already been given, with the corresponding Bombay times, in the deduction of the difference of longitude (*vide* pp. 191 *et seq.*)

1875, January 31

Number of signal	Set 1	Set 2	Set 3	Set 4
	Time by chronometer 43	Time by chronometer 43	Time by chronometer 43	Time by chronometer 43
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	5 36 10·0	5 44 59·0	5 51 49·9	5 59 10·2
2	20·2	45 8·5	52 0·0	20·0
3	30·0	18·5	10·1	30·1
4	40·0	28·9	20·1	40·0
5	50·1	46 9·1	30·1	50·0
6	37 10·2	19·1	50·1	6 0 10·0
7	20·2	29·2	53 [0·0*]	20·1
8	30·1	47 9·3	10·1	30·0
9	40·0	19·4	20·2	40·1
10	50·0	29·5	30·2	1 10·0
11	38 10·0	49·6	50·2	20·0
12	20·0	59·6	54 0·3	30·0
13	30·0	48 9·7	10·4	40·1
14	40·0	19·7	20·4	50·0
15	50·0	29·8	30·5	2 10·0
16	39 20·0	49·8	50·6	20·1
17	30·0	59·7	55 0·6	30·0
18	40·0	49 9·7	10·6	40·2
19	5 39 50·0	19·8	20·4	6 2 50·0
20	...	5 49 29·8	5 55 30·5	...

	Set 5	Set 6	Set 7	Set 8
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 0 10·2	14 11 37·8	14 21 9·2	14 16 10·0
2	20·0	47·7	19·2	20·0
3	30·0	12 7·8	29·1	30·0
4	40·1	17·8	39·1	40·0
5	50·0	27·8	49·2	49·9
6	1 10·0	38·0	22 9·3	17 10·1
7	20·1	47·9	19·3	20·0
8	30·0	13 8·0	29·3	30·0
9	40·0	18·0	39·4	40·0
10	50·0	28·0	49·4	50·0
11	2 10·1	38·0	23 9·3	18 10·2
12	30·0	48·0	19·4	20·0
13	50·0	14 8·1	29·5	30·0
14	3 10·0	18·0	49·3	40·0
15	20·0	28·1	24 9·7	50·0
16	30·0	38·0	19·7	19 9·9
17	40·0	14 14 48·1	29·7	20·0
18	14 3 50·0	...	39·8	30·0
19	...	...	14 24 49·5	40·0
20	...	...	...	14 19 50·0

[*] Signal doubtful.

We now give the chronometer and local sidereal times of the signals sent to and received from Suez, and, in order to deduce the difference of longitude, the Suez sidereal times of receipt and despatch of the corresponding signals at that end of the line are also given. We thus have :—

1875, JANUARY 30

SET 1

Number of signal	Time by chronometer 43	Aden sidereal time; signals *sent*	Corresponding Suez sidereal time; signals *received*	Resulting longitude, Aden east of Suez
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	15 4 40·0	14 16 29·30	13 26 45·96	0 49 43·34
2	50·2	39·51	55·99	43·52
3	5 10·2	59·51	27 16·35	43·16
4	20·1	17 9·41	26·77	42·64
5	30·0	19·31	36·10	43·21
6	40·1	29·41	46·13	43·28
7	50·1	39·41	56·26	43·15
8	6 10·1	59·41	28 16·31	43·10
9	20·2	18 9·51	26·54	42·97
10	30·0	19·31	36·17	43·14
11	40·0	29·31	46·20	43·11
12	50·0	39·31	56·33	42·98
13	7 10·0	59·31	29 16·18	43·13
14	20·0	19 9·31	26·41	42·90
15	40·1	29·41	46·27	43·14
16	15 7 50·0	14 19 39·31	13 29 56·39	42·92

SET 2

Number of signal	Time by chronometer 43	Aden sidereal time; signals *received*	Corresponding Suez sidereal time; signals *sent*	Resulting longitude, Aden east of Suez
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	15 10 58·9	14 22 48·22	13 33 4·01	0 49 44·21
2	11 8·9	58·22	13·93	44·29
3	28·7	23 18·02	33·89	44·13
4	48·9	38·22	54·14	44·08
5	12 18·8	24 8·12	34 24·03	44·09
6	28·8	18·12	34·06	44·06
7	48·8	38·12	53·82	44·30
8	59·1	48·42	35 4·45	43·97
9	13 9·2	58·52	14·57	43·95
10	29·1	25 18·43	34·23	44·20
11	49·0	38·33	53·98	44·35
12	59·0	48·33	36 4·21	44·12
13	14 9·0	58·33	14·44	43·89
14	19·1	26 8·43	24·36	44·07
15	29·2	18·53	34·29	44·24
16	49·2	38·53	54·45	44·08
17	59·3	48·63	37 4·17	44·46
18	15 9·1	58·43	14·50	43·93
19	19·2	27 8·53	24·13	44·40
20	29·2	18·53	34·66	43·87
21	49·4	38·73	54·81	43·92
22	58·2*	47·53	38 4·64	[42·89]
23	16 9·8	59·13	14·77	44·36
24	19·0	28 8·33	24·59	43·74
25	15 16 29·5	14 28 18·83	13 38 34·62	44·21

[*] This signal is marked uncertain at the Aden end; result rejected.

1875, JANUARY 30 (*continued*).

SET 3

Number of signal	Time by chronometer 43			Aden sidereal time; signals *sent*			Corresponding Suez sidereal time; signals *received*			Resulting longitude, Aden east of Suez		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	15	20	50·1	14	32	39·44	13	42	56·14	0	49	43·30
2		21	10·0			59·34		43	16·49			42·85
3			20·1		33	9·44			25·92			43·52
4			30·0			19·34			36·26			43·08
5			40·1			29·45			46·48			42·97
6		22	9·8			59·15		44	15·76			43·39
7			20·1		34	9·45			26·09			43·36
8	15	22	40·1	14	34	29·45	13	44	46·05			43·40

SET 4

Number of signal	Time by chronometer 43			Aden sidereal time; signals *received*			Corresponding Suez sidereal time; signals *sent*			Resulting longitude, Aden east of Suez		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	15	24	50·8	14	36	40·15	13	46	56·10	0	49	44·05
2		25	0·9			50·25		47	6·23			44·02
3			10·8		37	0·15			16·25			43·90
4			21·0			10·35			26·18			44·17
5			51·0			40·36			56·26			44·10
6		26	1·0			50·36		48	6·29			44·07
7			11·0		38	0·36			16·42			43·94
8			21·0			10·36			26·25			44·11
9			51·8			41·16			56·83			44·33
10		27	1·2			50·56		49	6·66			43·90
11			11·3		39	0·66			16·38			44·28
12			21·0			10·36			26·52			43·84
13			31·3			20·66			36·25			44·41
14			51·6			40·96			57·10			43·86
15		28*	1·5			50·86		50	6·93			43·93
16			11·2		40	0·56			16·96			43·60
17			21·2			10·56			26·69			43·87
18			31·2			20·56			36·71			43·85
19			51·7			41·06			56·47			44·59
20		29	1·4			50·76		51	6·89			43·87
21			11·6		41	0·96			16·62			44·34
22			21·7			11·06			26·55			44·51
23	15	29	31·7	14	41	21·06	13	51	36·57			44·49

1875, JANUARY 31

SET 5

Number of signal	Time by chronometer 43			Aden sidereal time; signals *sent*			Corresponding Suez sidereal time; signals *received*			Resulting longitude, Aden east of Suez		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	6	57	10·1	6	9	1·54	5	19	17·65	0	49	43·89
2			20·0			11·44			27·87			43·57
3			30·1			21·54			38·50			43·04
4			40·0			31·44			48·13			43·31
5			50·0			41·44			58·16			43·28
6		58	10·1		10	1·54		20	17·81			43·73
7			20·0			11·44			28·14			43·30
8			30·0			21·44			37·87			43·57
9			40·1			31·54			47·89			43·65
10			50·0			41·44			57·92			43·52
11		59	10·0		11	1·44		21	18·07			43·37
12			20·0			11·44			28·00			43·44
13			30·0			21·44			37·93			43·51
14			40·1			31·54			47·96			43·58
15	7	0	10·0		12	1·44		22	18·04			43·40
16			20·0			11·45			28·07			43·38
17			30·0			21·45			38·09			43·36
18			40·0			31·45			48·02			43·43
19	7	0	50·1	6	12	41·55	5	22	57·95			43·60

* 23^m in original.

1875, JANUARY 31 (*continued*).

SET 6

Number of signal	Time by chronometer 43	Aden sidereal time; signals *received*	Corresponding Suez sidereal time; signals *sent*	Resulting longitude, Aden east of Suez
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	7 3 23·5	6 15 14·95	5 25 31·07	0 49 43·88
2	33·7	25·15	40·59	44·56
3	43·7	35·15	50·62	44·53
4	53·8	45·25	26 0·65	44·60
5	4 3·8	55·25	10·67	44·58
6	43·9	16 35·36	50·98	44·38
7	53·9	45·36	27 1·11	44·25
8	5 4·0	55·46	11·04	44·42
9	24·1	17 15·56	31·29	44·27
10	33·9	25·36	40·92	44·44
11	44·1	35·56	51·05	44·51
12	6 4·0	55·46	28 11·00	44·46
13	24·2	18 15·66	31·66	44·00
14	33·9	25·36	41·19	44·17
15	44·2	35·76	51·21	44·55
16	54·2	45·66	29 1·34	44·32
17	7 7 4·3	6 18 55·76	5 29 11·27	44·49

SET 7

Number of signal	Time by chronometer 43	Aden sidereal time; signals *received*	Corresponding Suez sidereal time; signals *sent*	Resulting longitude, Aden east of Suez
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	7 10 24·3	6 22 15·77	5 32 31·91	0 49 43·86
2	34·6	26·07	41·84	44·23
3	44·7	36·17	51·97	44·20
4	54·9	46·37	33 2·50	43·87
5	11 4·9	56·37	12·34	44·03
6	25·0	23 16·47	31·89	44·58
7	34·9	26·37	42·42	43·95
8	44·9	36·37	52·75	43·62
9	55·0	46·47	34 1·97	44·50
10	12 5·0	56·47	12·00	44·47
11	25·1	24 16·57	32·65	43·92
12	35·2	26·67	42·58	44·09
13	45·2	36·67	52·81	43·86
14	55·3	46·77	35 2·94	43·83
15	13 5·2	56·67	12·36	44·31
16	25·2	25 16·67	32·32	44·35
17	35·3	26·78	42·24	44·54
18	45·2	36·68	52·27	44·41
19	56·1	47·58	36 2·30	[45·28*]
20	7 14 5·3	6 26 56·78	5 36 12·43	44·35

SET 8

Number of signal	Time by chronometer 43	Aden sidereal time; signals *sent*	Corresponding Suez sidereal time; signals *received*	Resulting longitude, Aden east of Suez
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	7 15 10·0	6 27 1·48	5 37 18·01	0 49 43·47
2	20·1	11·58	28·23	43·35
3	30·0	21·48	37·76	43·72
4	40·0	31·48	48·29	43·19
5	50·0	41·48	57·81	43·67
6	16 10·0	28 1·48	38 18·37	43·11
7	20·0	11·48	27·70	43·78
8	30·0	21·48	37·93	43·55
9	40·0	31·48	47·95	43·53
10	50·0	41·48	57·78	43·70
11	17 10·0	29 1·48	39 17·83	43·65
12	20·0	11·48	27·86	43·62
13	30·0	21·48	37·89	43·59
14	40·0	31·48	47·92	43·56
15	50·0	41·48	58·04	43·44
16	18 10·0	30 1·49	40 18·10	43·39
17	20·0	11·49	28·02	43·47
18	30·0	21·49	38·05	43·44
19	40·0	31·49	48·08	43·41
20	7 18 50·0	6 31 41·49	5 40 58·11	43·38

[*] This result is probably 1ˢ wrong; rejected.

1875, JANUARY 31 (*continued*)

SET 9

Number of signal	Time by chronometer 43	Aden sidereal time; signals *sent*	Corresponding Suez sidereal time; signals *received*	Resulting longitude, Aden east of Suez
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 43 20·0	13 55 12·35	13 5 28·98	0 49 43·37
2	30·0	22·35	39·01	43·34
3	40·0	32·35	48·93	43·42
4	50·0	42·35	58·96	43·39
5	44 9·9	56 2·25	6 18·42	43·83
6	20·0	12·35	29·14	43·21
7	30·0	22·35	39·07	43·28
8	40·0	32·35	49·00	43·35
9	50·0	42·35	58·93	43·42
10	45 10·0	57 2·35	7 18·98	43·37
11	20·0	12·35	29·11	43·24
12	30·1	22·45	39·04	43·41
13	40·0	32·35	48·76	43·59
14	50·0	42·35	58·99	43·36
15	46 20·0	58 12·36	8 29·17	43·19
16	30·0	22·36	39·10	43·26
17	40·0	32·36	48·63	43·73
18	14 46 50·1	13 58 42·46	13 8 58·85	43·61

SET 10

Number of signal	Time by chronometer 43	Aden sidereal time; signals *received*	Corresponding Suez sidereal time; signals *sent*	Resulting longitude, Aden east of Suez
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 49* 59·9	14 1 52·26	13 12 7·98	0 49 44·28
2	50 10·0	2 2·36	17·91	44·45
3	19·9	12·26	28·13	44·13
4	40·1	32·46	48·19	44·27
5	50·0	42·36	58·22	44·14
6	51 0·0	52·36	13 8·24	44·12
7	10·0	3 2·36	18·27	44·09
8	19·9	12·27	28·30	43·97
9	41·0	33·27	48·65	44·72
10	51·0	43·37	59·18	44·19
11	52 0·2	52·57	14 8·31	44·26
12	10·2	4 2·57	18·44	44·13
13	20·3	12·67	28·46	44·21
14	40·4	32·77	48·52	44·25
15	50·8	43·17	58·55	44·62
16	53 0·3	52·67	15 8·47	44·20
17	10·5	5 2·87	18·50	44·37
18	14 53 21·3	14 5 13·67	13 15 29·33	44·34

SET 11

Number of signal	Time by chronometer 43	Aden sidereal time; signals *received*	Corresponding Suez sidereal time; signals *sent*	Resulting longitude, Aden east of Suez
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 57 52·0	14 9 44·38	13 20 0·18	0 49 44·20
2	58 11·0	10 3·38	19·23	44·15
3	21·3	13·68	29·36	44·32
4	42·0	34·38	49·61	44·77
5	59 1·3	53·68	21 9·47	44·21
6	11·4	11 3·78	19·50	44·28
7	21·2	13·58	29·72	43·86
8	41·6	33·98	49·88	44·10
9	51·8	44·18	59·71	44·47
10	15 0 1·3	53·68	22 9·73	43·95
11	11·7	12 4·08	19·76	44·32
12	21·5	13·88	29·70	44·18
13	41·8	34·18	49·85	44·33
14	51·3	43·68	59·68	44·00
15	15 1 1·7	14 12 54·08	13 23 9·81	44·27

* Hours and minutes supplied.

1875, JANUARY 31 (*continued*)

SET 12

Number of signal	Time by chronometer 43	Aden sidereal time; signals *sent*	Corresponding Suez sidereal time; signals *received*	Resulting longitude, Aden east of Suez
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	15 10 50·2	14 22 42·60	13 32 59·43	0 49 43·17
2	11 10·1	23 2·50	33 19·38	43·12
3	20·0	12·40	29·21	43·19
4	30·0	22·40	39·44	42·96
5	40·0	32·40	49·37	43·03
6	50·1	42·50	59·50	43·00
7	12 10·0	24 2·41	34 19·56	42·85
8	20·0	12·41	28·98	43·43
9	30·0	22·41	38·91	43·50
10	40·0	32·41	48·74	43·67
11	50·2	42·61	59·57	43·04
12	13 10·0	25 2·41	35 19·12	43·29
13	20·0	12·41	29·05	43·36
14	30·0	22·41	38·97	43·44
15	40·0	32·41	48·90	43·51
16	15 13 50·0	14 25 42·41	13 35 59·13	43·28

Classifying the sets and taking the means, we obtain :—

Difference of Longitude by Signals sent from Aden and recorded at Suez.

Date	Set	No. of signals	Resulting longitude, Aden east of Suez	
			h. m. s.	h. m. s.
1875, Jan. 30 . . .	1	16	0 49 43·106	0 49 43·170
	3	8	43·234	
„ 31 . . .	5	19	0 49 43·470	0 49 43·486
	8	20	43·501	
„ 31 . . .	9	18	0 49 43·409	0 49 43·324
	12	16	43·240	

Difference of Longitude by Signals sent from Suez and recorded at Aden.

Date	Set	No. of signals	Resulting longitude, Aden east of Suez	
			h. m. s.	h. m. s.
1875 Jan. 30 . . .	2	24	0 49 44·122	0 49 44·105
	4	23	44·088	
„ 31 . . .	6	17	0 49 44·377	0 49 44·266
	7	19	44·156	
„ 31 . . .	10	18	0 49 44·263	0 49 44·245
	11	15	44·227	

Combining these results, on the supposition that the current time is the same in both directions, we have :—

		h. m. s.		s.
Jan. 30 . . .	Aden east of Suez	0 49 43·638	Current time	0·468
„ 31 . . .	„	43·876	„	0·390
„ 31 . . .	„	43·784	„	0·460

Since for January 30 there was no time determination at Aden, the chronometer correction depending upon uniformity of rate of the chronometers, and since at Suez there was only one group of observations on this night, half weight is given to the longitude result of this day. We thus get :—

	h.	m.	s.
Aden east of Suez	0	49	43·79
Correction for personal equation between Dr. Löw and Mr. Gill* { in observing transits . .			−0·06
Correction for personal equation between Dr. Löw and Mr. Gill* { in recording signals . .			+0·02

Or finally—

	h.	m.	s.
Aden east of Suez	0	49	43·75

and— Current time . . . . . 0·439

* Details of these determinations will be found in Chapter XVI.

CHAPTER XIV.

OPERATIONS AT SUEZ.

THE observations at Suez were made principally to determine the corrections of the chronometer used in the exchanges of telegraphic signals with Aden and Alexandria. Mr. Gill remaining at Suez for a short time on the way to Alexandria, he took the opportunity of making determinations of the difference of personal equation between Dr. Löw and himself, both in determining the time with their respective instruments, and also in observing signals with the 'Thomson' galvanometer. The difference of longitude between the station occupied by the British Government Expedition for observing the Transit of Venus, and that occupied on behalf of Lord Lindsay for longitude operations, was also determined.

TIME DETERMINATIONS AT SUEZ.

The following observations were taken with Dr. Löw's transit instrument :—

OBSERVER, DR. LÖW; CHRONOMETER NIEBERG.

Date, 1875	Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of transit over wire VI.			Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.					
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Jan. 30	α Boötis	W	10·2	23·4	...	...	...	48·8	...	1·2	...	14·4	27·4	19	8	48·79	−14·8 +21·0	−42·2 +48·7
	ϕ Virginis	„	...	8·2	...	20·5	...	32·4	...	44·1	...	[55·7*]	[7·3*]	19	20	32·36	...	...
	ρ Boötis	„	34·3	48·3	...	2·3	...	16·7	...	30·2	...	44·5	58·2	19	25	16·38	+19·9 −17·9	+47·4 −45·3
	π^1 Boötis	E	14·3	2·4	...	49·7	...	36·8	...	24·3	...	11·2	59·1	19	33	36·81	...	...
	ϵ Boötis	„	58·9	45·3	...	31·6	...	17·8	...	4·2	...	50·7	[36·2*]	19	38	17·92	+15·7 − 8·8	+43·2 −36·5
	α Libræ	„	16·1	3·5	...	50·5	...	38·5	...	26·2	...	13·3	...	19	42	38·40	...	...
	β Urs. min.	„	24·5	39·0	8·5	53·5	[37·2*]	7·5	37·1	22·5	6·9	36·5	...	19	50	7·67	−11·7 +10·3	−39·2 +38·0
	ψ Boötis	„	28·8	15·3	...	1·3	...	48·2	...	35·1	...	21·2	7·8	19	57	48·22	+16·0 − 5·9	+43·2 −33·4
	δ Boötis	W	27·2	41·6	...	55·5	...	10·3	...	25·2	...	39·4	54·1	20	9	10·50	+10·2 − 5·4	+37·7 −32·9
	11 Urs. min.	„	10·1	50·1	16·5	...	...	...	...	...	...	...	...	20	16	9·12	...	...
	„	E	...	26·3	59·7	46·4	33·7	...	...	...	...	...	...			7·03	+10·0 − 8·5	+37·3 −35·5
	γ Urs. min.	„	...	...	43·0	29·7	16·9	49·8	23·2	...	57·2	...	...	20	19	50·00	+13·0 − 7·2	+40·1 −34·5
	α Coronæ	„	41·8	28·5	...	14·3	...	1·4	...	47·2	...	34·2	...	20	28	1·10	...	...
Jan. 31, 1st group	Groom. 2283 S.P.	E	...	...	5·0	45·5	23·0	..	...	...	...	...	...	8	14	45·43	−27·9 +19·3	−46·9 +38·7
	„	W	...	...	9·8	30·0	52·5	...	...	...	...	...	...			29·84	−24·7 +18·2	−43·9 +37·5
	ϵ Eridani	„	6·4	18·5	...	30·6	...	42·9	...	55·4	...	7·3	19·7	8	23	42·99	...	...
	10 Tauri	„	33·5	45·5	...	57·4	...	9·6	...	21·3	...	33·8	45·8	8	27	9·58	+17·2 −24·8	+36·7 −44·4

[*] These wires discordant; rejected.

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, DR. LÖW; CHRONOMETER NIEBERG (*continued*).

Date, 1875	Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of transit over wire VI.			Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII	IX.	X.	XI.					
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Jan. 31, 1st group (*cont.*)	Camel. 5 H.	W	...	39·8	4·9	17·0	29·4	...	18·2	30·1	12·9	7·6	44·9	8	33	53·85	...	...
	31 Tauri	„	21·3	33·4	...	46·1	...	58·3	...	10·2	...	22·4	34·6	8	41	58·07	−27·2 +20·9	−47·0 +40·6
	Lacaille 1273	„	3·4	17·4	...	30·2	...	44·2	...	...	...	11·3	25·4	8	45	44·27	...	...
	Groom. 750	„	...	0·5	37·8	26·1	13·9	...	...	...	...	...	...	8	54	50·82	+21·1 −28·8	+40·8 −47·4
	„	E	...	...	55·1	7·0	19·4	...	...	...	...	...	...			42·13	+23·1 −26·7	+43·2 −46·7
	o^1 Eridani	„	55·5	43·5	...	31·8	...	...	...	...	...	...	...	9	2	19·29	...	...
	γ Tauri	„	51·1	38·5	...	26·0	...	13·5	...	1·3	...	...	36·3	9	9	13·60	−30·7 +18·0	−50·4 +38·0
	δ Tauri	„	53·1	40·9	...	28·2	...	...	...	3·2	...	50·4	37·8	9	12	15·58	+17·5 −23·0	+37·8 −43·1
	ϵ Tauri	„	28·3	15·5	...	3·1	...	50·2	...	37·8	...	25·0	12·2	9	17	50·28	...	...
	Groom. 848	„	2·6	13·7	40·9	24·3*	8·2	35·8	2·9	47·1	30·9	58·1	8·9	9	28	35·69	−26·7 +20·0	−46·9 +40·3
	μ Eridani	„	19·5	7·5	...	55·5	...	43·2	...	31·6	...	19·3	...	9	35	43·37	+23·8 −26·8	+44·2 −47·1
	π^4 Orionis	„	36·6	24·2	...	12·4	...	0·3	...	48·4	...	36·5	24·1	9	41	0·33	−30·0 +20·0	−50·4 +40·3
	^{5} Orionis	„	47·4	35·3	...	23·2	...	11·5	...	59·1	...	47·4	35·4	9	44	11·30	...	...
	ϵ Urs. min. S.P.	„	37·0	6·5	5·5	35·5	4·3	...	...	...	...	...	...	9	55	4·52	+11·0 −17·5	+31·8 −38·1
	„	W	28·0	59·0	59·3	30·0	0·8	...	...	...	...	...	...			0·66	+11·5 −14·1	+32·2 −34·7
Jan. 31, 2nd group	ν Orionis	W	4·7	17·6	...	29·9	...	42·5	...	54·6	...	7·4	19·8	10	56	42·38	−14·7 +13·8	−35·8 +34·9
	η Geminorum	„	56·2	9·5	...	22·4	...	35·4	...	48·2	...	1·2	14·6	11	3	35·38	...	...
	δ Urs. min. S.P.	„	17·8	...	...	...	24·5	6·5	52·0	...	...	...	...	11	8	7·46	+ 8·3 −14·2	+29·2 −35·6
	μ Geminorum	„	...	...	...	...	...	37·5	...	50·9	...	4·4	17·4	11	11	38·01	...	...
	γ Geminorum	„	2·5	15·3	...	27·5	...	40·2	...	52·6	...	5·3	17·9	11	26	40·71†	−14·0 + 6·8	−35·2 +28·0
	15 Monocerotis	„	39·1	51·5	...	3·8	...	16·0	...	28·4	...	40·6	53·0	11	30	16·08	...	...
	ξ Geminorum	„	49·3	1·5	...	14·1	...	26·3	...	38·1	...	51·5	3·5	11	34	26·35	+12·3 −16·2	+33·7 −37·9
	Cephei 51 H.	„	...	...	...	...	...	19·0	6·5	...	...	...	...	11	38	19·28	...	...
	„	E	37·4	25·3	39·0	...	...	...	...	...	...	...	...			5·50	−18·9 + 8·0	−40·7 +29·8
	52 Geminorum	„	48·1	34·8	...	21·4	...	8·2	...	54·9	...	41·4	28·2	12	3	8·12	...	...
	ι Geminorum	E	41·9	28·2	...	14·9	...	0·8	...	47·3	...	33·3	20·1	12	14	0·90	+ 9·8 −12·0	+31·2 −33·7
	β Can. min.	„	1·1	...	...	36·7	...	24·8	...	12·0	...	0·1	48·1	12	16	24·50‡	−13·0 +15·2	−34·9 +36·9
	Groom. 2900 S.P.	„	...	...	...	...	...	59·2	43·0	4·5	26·1	9·2	15·5	12	24	59·49	+ 8·8 −19·5	+30·2 −41·1
Jan. 31, 3rd group	Drac. 4 H.	E	...	...	1·5	42·0	22·1	42·8	2·2	...	24·4	44·3	43·9	17	1	42·58	+14·8[**] −14·9	+37·1 −37·2
	η Virginis	„	19·1	7·3	...	55·2	...	43·3	...	31·2	...	19·3	7·2	17	8	43·20§	−14·0 +11·3	−36·4 +33·9
	B.A.C. 4165	W	...	...	...	...	...	...	[37·5][‖]	[0·0][‖]	42·3	27·0	...	17	11	11·49	−14·0 +20·2	−36·4 +42·6
	δ Virginis	„	49·3	1·4	...	13·5	...	25·3	...	37·3	...	49·4¶	1·8	17	44	25·45	...	...
	ϵ Virginis	„	26·2	39·4	...	51·2	...	3·7	...	15·1	...	28·3	40·4	17	51	3·50	+19·8 −26·7	+42·2 −49·1

* 29^s·3 in original.
§ Minute supplied.
† In accordance with a note by the observer, this mean has been increased 0^s·5.
[‖] These wires discordant; rejected.
¶ 59^s·4 in original.
‡ 15^m in original.
[**] 'Neigung corrigirt.'

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, DR. LÖW; CHRONOMETER NIEBERG (*continued*).

Date, 1875	Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of transit over wire VI.			Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.					
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Jan. 31, 4th group	κ Virginis	W	30·7	42·9	...	55·4	...	7·2	...	19·2	...	31·6	44·2	19	1	7·34	−27·0	−50·0
																	+22·0	+45·0
	4 Urs. min.	„	...	...	...	26·5	46·2	25·0	4·2	23·2	43·2	...	...	19	4	25·19	+25·2	+48·2
																	−23·7	−46·4
	φ Virginis	„	...	12·6	...	25·0	...	36·6	...	49·0	...	0·8	13·3	19	16	36·88	...	...
	ρ Boötis	„	35·9	50·1	...	...	...	18·0	...	32·0	...	45·8	0·1	19	21	18·00	−25·0	−48·0
																	+22·9	+45·5
	π Boötis	E	17·4	5·0	...	52·5	...	39·9	...	27·4	...	...	2·2	19	29	39·85	...	...
	ε Boötis	„	0·8	46·9	...	33·7	...	19·8	...	6·7	...	52·7	39·4	19	34	19·97	−21·0	−43·9
																	+24·1	+47·1
	α Libræ	„	21·6	9·4	...	56·5	...	44·4	...	31·8	...	19·3	6·5	19	38	44·19	...	...
	β Urs. min.	„	12·5	26·7	56·0	41·0	26·0	55·7	25·2	10·1	55·0	24·5	38·8	19	45	55·52	...	...
Feb. 5	α Urs. min. S.P.	E	...	...	...	...	...	...	22·5	8·2	0·5	...	...	17	47	41·39	+10·7	+35·4
																	−15·6	−40·2
	„	W	47·5	11·0	...	...	...	...	...	...	...	...	...			9·49	+11·5	+36·2
																	− 6·0	−31·1
	η Urs. maj.	„	47·2	5·9	18·2	...	30·8	43·4	56·0	...	8·0	20·8	39·7	18	17	43·35	...	...
	η Boötis	„	10·5	23·4	...	36·0	...	49·1	...	1·4	...	14·3	[24·2*]	18	23	48·85	−10·0	−35·1
																	+ 0·7	+25·7
	Virginis	„	...	56·3	...	...	...	20·3	...	32·1	...	44·6	56·5	18	30	20·34	−18·0	−43·1 †
																	+27·2	+52·1 †
	α Boötis	„	20·2	33·3	...	46·2	...	58·9	...	11·2	...	24·5‡	37·4	18	44	58·84	+12·6	+37·6
																	−15·7	−41·0
	ρ Boötis	E	5·9	51·5	...	37·5	...	23·7	...	9·8	...	56·0	41·8	19	1	23·72	+19·9	+45·1
																	−13·8	−38·9
	109 Virginis	„	27·4	15·2	...	3·3	...	50·5	...	39·2	...	26·9	14·4	19	14	50·96	−11·8	−36·9
																	+13·8	+39·0
	β Boötis	„	54·4	38·5	...	22·1	...	6·4	...	50·7	...	34·7	18·6	19	32	6·45	+18·0	+43·3
																	−15·2	−40·4
	β Libræ	„	43·2	31·1	...	19·3	...	6·8	...	54·8	...	42·7	30·2	19	45	6·85	−11·8	−37·0
																	+14·5	+39·7
	γ Urs. min.	„	42·9	2·9	36·2	23·3	10·2	44·0	17·1	4·5	51·2	24·2	...	19	55	43·70	−12·3	−37·8
																	+13·4	+39·0
Feb. 6	α Urs. min.	E	...	...	...	...	...	...	15·0	31·0	36·0	...	...	5	44	56·34	+19·0	+43·8
																	−17·9	−37·7
	„	W	...	...	...	...	...	...	5·5	50·5	47·0	...	...		45	25·32	+14·9	+34·6
																	−21·6	−41·4
	β Arietis	„	10·3	23·3	...	35·7	...	48·4	...	1·4	...	13·9	27·2	6	20	48·62	−22·5	−42·7
																	+14·6	+34·7
	γ Andromedæ	E	3·9	47·6	...	31·6	...	15·2	...	59·6	...	43·2	27·2	6	29	15·44	+13·3	+34·0
																	−20·2	−40·9
	α Arietis	„	48·3	35·5	...	22·1	...	9·2	...	56·0	...	42·7	29·9	6	33	9·07	[−20·2§	[−40·7
																	+13·0]	+32·4]
	δ Ceti	„	37·5	25·2	...	13·3	...	1·4	...	49·1	...	37·4	24·8	7	6	1·22	−21·5	−42·1
																	+22·8	+43·2
	41 Arietis	„	12·9	59·7	...	45·8	...	32·4	...	18·9	...	5·5	51·8	7	15	32·40	+23·0	+43·7
																	−20·3	−41·2
	β Urs. min. S.P.	„	46·5	31·9	1·9	17·7	32·4	3·0	33·3	48·0	3·3	34·0	19·9	7	24	2·97	−24·0	−45·2
																	+21·9	+42·8
	β Persei	W	...	23·7	...	39·4	...	55·2	...	10·9	...	26·8	42·8	7	32	55·24	+16·4	+37·8
																	−19·4	−40·6
	α Persei	„	18·9	37·5	49·9	56·0	1·9	14·5	27·2	...	39·2	51·2	10·4	7	48	14·54	+15·7	+37·0
																	−17·3	−39·3
	ξ Tauri	„	37·4	49·4	...	1·4	...	13·5	...	25·5	...	37·9	50·2	7	53	13·64	...	...
	f Tauri	„	10·5	23·2	...	35·4	...	47·5	...	59·9	...	12·3	24·8	7	56	47·68	−16·8	−38·6
																	+13·8	+35·5

[*] These wires discordant; rejected. † 'Nullpunkt des Niveau corrigirt.' ‡ 25ˢ·5 in original. [§] One level-reading one part wrong; not used.

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, DR. LÖW; CHRONOMETER NIEBERG (*continued*).

Date, 1875	Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of transit over wire VI.			Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.					
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Feb. 7	*α* Andromedæ	W	37·2	50·7	...	4·6	...	18·3	...	31·6	...	45·6	59·3	4	31	18·21	−19·8	−39·0 *
																	+14·2	+33·3
																	+18·5	+37·8
																	−19·0	−38·1
	α Cassiopeiæ	„	37·7	59·9	13·9	21·0	28·4	42·3	56·9	3·7	11·2	25·4	47·0	5	2	42·53	−18·9	−38·0
																	+15·7	+34·9
	β Ceti	„	...	10·2	...	23·2	...	35·9	...	...	...	1·5	14·0	5	6	35·88	+18·6	+37·9
																	−13·1	−32·3
	γ Cassiopeiæ	„	12·3	36·7	52·8	0·6	8·6	24·8	41·0	48·9	56·8	13·0	37·1	5	18	24·82	−12·3	−31·7
																	+12·4	+31·8
	β Andromedæ†	„	12·7	27·5	...	41·7	...	56·8	...	11·1	...	26·1	40·9	5	31	56·71	...	...
	α Ursæ min.	„	...	46·0	...	...	5·0	48·0	...	...	...	...	...	5	41	48·08	+11·3	+30·8
																	− 9·6	−29·1
	„ „	E	56·8	22·0	42·5	53·0	...	...	...	...	...	...	...			20·64	+15·8	+35·4
																	−13·7	−33·3
																	−13·7	−33·3
																	+19·6	+39·2
	β Arietis	„	27·5	14·5	...	1·1	...	48·8	...	36·2	...	23·3	10·3	6	16	48·79	+22·3	+42·1
																	−15·4	−35·3
	γ Andromedæ	„	5·4	49·2	...	33·2	...	16·9	...	0·8	...	44·5	28·5	6	25	16·90	−16·7	−36·8
																	+18·8	+38·8
	α Arietis	„	49·5	36·6	...	23·4	...	10·2	...	57·4	...	44·4	31·2	6	29	10·36	...	...
	β Trianguli	„	52·5	37·9	...	23·6	...	9·3	...	...	...	...	...	6	31	8·90	+16·4	+36·3
																	−14·4	−34·4
Feb. 8	*ε* Urs. min. S.P.	E	54·8	24·2‡	...	53·5	22·2	...	...	...	...	...	...	9	23	22·42	− 8·9	−30·7
																	+17·2	+38·9
	„ „	W	44·5	15·0	14·0	45·3	15·3	...	...	...	...	...	...			16·07	−16·0	−37·9
																	+17·9	+39·7
	β Tauri	„	17·3	31·1	...	44·9	...	58·5	...	12·2	...	25·9	39·7	9	42§	58·54	+14·6	+36·7
																	−12·9	−35·0
	122 Tauri	„	[47·5‖]	...	...	9·1	...	21·5	...	34·1	...	46·7	59·5	9	54	21·61	−15·7	−37·8
																	+15·2	+37·5
	o Aurigæ	„	50·0	8·9	21·0	...	33·5	46·2	58·7	...	10·8	23·3	41·9	10	0	46·05	+12·3	+34·7
																	−10·3	−32·8
	χ^2 Orionis	E	40·4	27·8	...	14·8	...	1·7	...	49·4	...	36·6	23·5	10	12¶	2·00	+17·2	+39·9
																	−18·7	−41·4
	66 Orionis	„	25·8	13·6	...	1·4	...	49·6	...	37·5	...	...	...	10	22	49·47	−19·7	−42·3
																	+17·0	+39·9
	δ Urs. min. S.P.	„	32·5	56·0	12·5	20·0	27·0	43·9	58·1	...	14·0	30·0	54·5	10	36	43·36	+17·2	+40·1
																	−12·9	−35·7
	51 Aurigæ	„	9·5	54·2	43·3	...	33·6	22·6	12·6	...	1·5	51·7	35·5	10	54	22·71	−13·0	−36·0
																	+15·2	−38·2
Feb. 9, 1st group	*α* Andromedæ	E	...	[50·1[a]]	...	35·7	...	...	...	7·9	...	...	40·3	4	23	21·62	−15·3	−34·5
																	+ 9·2	+28·3
	α Cassiopeiæ	„	50·0	28·7	[13·3‖]	7·2	59·9	45·5	31·3	24·2	17·2	2·3	41·1	4	54	45·56	+ 6·7	+25·5
																	−12·9	−31·9
	γ Cassiopeiæ	„	40·7	16·2	0·3	52·2	44·4	28·4	...	4·3	56·2	40·2	16·0	5	10	28·24	+13·7	+32·9
																	−17·8	−37·1
	β Andromedæ	„	44·4	29·3	19·3	...	10·0	0·2	...	...	...	30·9	16·2	5	24	0·12	−15·7	−34·9
																	+20·0	+39·4
	α Ursæ min.	E	...	...	...	...	...	40·0	57·0	...	...	42·5	7·0	5	33	41·25	−15·5	−34·4
																	+17·3	+36·3
	„ „	W	...	...	...	...	...	...	49·5††	28·5	26·8	7·0	40·5		34	5·55	+14·5	+33·9
																	−17·7	−37·0
																	−17·4	−36·8
																	+19·3	+38·8
	γ Andromedæ	„	[37·3‖]	49·5	0·7	...	11·7	22·1	33·2	...	43·8	54·5	10·8	6	17	22·24	+15·0	+34·7
																	−17·3	−37·0
																	−21·4	−41·2
																	+21·7	+41·5

* 'Neigung corrigirt.' † In accordance with a note by Dr. Löw, the last four wires have each been increased 1ˢ.

‡ 34ˢ·2 in original. § 43ᵐ in original. [‖] These wires discordant; rejected. ¶ 7ᵐ in original.

[a] Noted by observer as 'sehr schlecht;' rejected. †† 'Lärm' at this wire.

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, DR. LÖW; CHRONOMETER NIEBERG (*continued*).

Date, 1875	Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of transit over wire VI.			Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.					
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Feb. 9, 1st group (*cont.*)	α Arietis	W	36·4	49·6	...	2·3	...	15·5	...	28·6	...	41·4	54·4	6	21	15·48	+17·9 −12·7	+37·9 −32·6 *
Feb. 9, 2nd group	δ Urs. min. S.P.	W	41·0	19·0	2·5	54·8	47·5	31·0	15·5	9·5	0·2	45·0	22·0	10	32	31·31	−25·0 +24·7 +24·6 −27·7	−47·0 +46·7 +46·7 −49·9
	Cephei 51	„	49·0	0·5	47·3	10·3	32·5	22·0	...	...	...	...	...	11	2	20·91	−16·0 +16·5	−38·7 +39·3
	„	E	36·5	24·6	39·0	15·5	53·0	...	...	...	...	...	...			4·95	−20·8 +15·4	−43·2 +38·3
	64 Aurigæ	„	26·8	10·8	0·1	...	49·5	38·8	28·3	...	17·6	6·7	50·9	11	29	38·82	+18·8 −15·9	+41·8 −38·9
	56 Geminorum	„	29·8	16·4	...	4·2	...	51·4	...	38·2	...	25·7	12·6	11	34	51·16	−16·8 +15·3	−39·9 +38·4
	58 Geminorum	W	6·6	19·4	...	31·8	...	44·5	...	56·7	...	9·5	22·0	11	46	44·38	−18·1 +13·3	−41·2 +36·3
	o Geminorum	„	31·8	46·8	56·2	...	6·6	16·0	25·9	...	35·7	45·4	0·1	11	51	16·07	+14·9 −16·9	+38·1 −40·2
	26 Lyncis	„	56·6	14·4	26·2	...	38·6	50·2	1·9	...	14·4	26·3	44·4	12	5	50·35	−15·2 +13·5	−38·6 +36·6
	ω^2 Cancri	„	42·3	56·4	...	9·3	...	22·8	...	36·6	...	49·7	[37†]	12	14	22·89	+14·2 −16·9	+37·3 −40·1
	Piazzi VII. 321	E	40·4	26·3	...	12·2	...	...	...	43·2	...	28·9	14·3	12	23	57·52	...	...
	χ Cancri	„	16·7	3·2	...	49·5	...	35·7	...	22·1	...	8·4	55·1	12	32	35·79	−14·4 +21·0	−37·7 +44·2

* After this observation the instrument was cleaned.

[†] Observer notes this wire $\frac{1}{2}^s$ wrong; rejected.

Observations were taken with the Troughton and Simms' altazimuth, used as a transit instrument. It was brought as nearly as might be into the meridian, and a sufficient number of observations having been secured in one position, the instrument was reversed by turning it 180° in azimuth, and a corresponding set taken in the second position.

OBSERVER, MR. GILL; CHRONOMETER 43.

Date, 1875	Name of star	Position of circle	Level readings		Seconds of transit over the wires					Concluded chronometer time of transit over wire III.			Level readings	
					I.	II.	III.	IV.	V.					
			E	W									E	W
			p.	p.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Feb. 9, 1st group	α Andromedæ	E	11·5 24·0	21·4 8·6	48·0	32·8	17·3	2·5	47·4	1	39	17·45	13·9 23·2	19·8 10·6
	α Cassiopeiæ	„	12·8 24·3	22·2 10·4	41·9	17·4	54·0	30·8	7·1	2	10	54·01	13·0 23·5	22·0 11·5
	γ Cassiopeiæ	„	23·6 14·0	11·5 21·4	35·5	...	41·5	15·2	48·1	2	26	41·38	13·1 23·1	22·0 12·0
	β Andromedæ	„	...	...	40·1	23·7	...	...	...	2	40	7·40	12·9 23·2	22·6 12·2
	α Urs. min.	„	20·6 15·0	14·6 20·4	...	...	...	3·0	28·0	2	55	13·16	...	...
	„ „	W	...	...	...	...	15·0	33·0	52·0	2	56	14·89	12·0 22·0	24·0 14·0
	β Arietis	„	...	...	37·3	52·0	6·0	20·1	34·2	3	25	6·06	12·8 21·0	23·7 15·0
	Andromedæ	„	21·2 11·4	15·0 25·0	4·2	22·8	40·5	57·9	15·7	3	33	40·40	...	...
	α Arietis	„	...	...	...	15·5	30·0	44·3	58·9	3	37	30·06	...	...
	β Trianguli	„	...	...	...	15·2	31·0	47·1	3·3	3	39	31·20	13·5 21·0	22·9 15·6

The following observations of time stars in the vertical of the pole star were also taken with the Troughton and Simms' altazimuth :—

OBSERVER, MR. GILL; CHRONOMETER 43.

Date, 1875	Pole star	Position of circle	Chronometer time of pole star on wire III.	Level readings	Time star	Chronometer times of transit over the wires					Level readings
						I.	II.	III.	IV.	V.	
			h. m. s.	E p. W p.		s.	s.	h. m. s.	s.	s.	E p. W p.
Feb. 9, 2nd group	*a* Ursæ min.	E	8 56 27·0	13·5 26·0 / 25·2 14·2	68 Geminorum	47·1	33·0	9 2 19·3	5·7	52·0	25·2 14·3 / 13·8 25·7
	,, ,,	,,	,,	,, ,,	*o* Geminorum	36·7	20·1	9 9 4·0	48·2	31·5	14·0 25·8 / 24·9 15·0
	,, ,,	,,	,,	,, ,,	26 Lyncis	32·5	12·0	9 25 52·5	32·9	...	25·1 14·0 / 13·5 25·7
	,, ,,	,,	,,	,, ,,	ω^2 Cancri	33·0	18·0	9 31 3·2	48·7	34·0	... ...
	a Ursæ min.	W	9 37 53·0	23·3 15·8 / 12·0 27·2	Piazzi VII. 321*	4·0	20·4	9 41 0	...	7·5	23·0 16·3 / 12·3 27·0
	,, ,,	,,	,,	,, ,,	χ Cancri	6·4	21·8	9 49 36·8	51·8	6·5	11·9 27·2 / 23·0 16·3

* Star very faint.

These observations were made by Mr. Gill for the determination of personal equation between Dr. Löw and himself.

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT.

OBSERVER, MR. GILL; CHRONOMETER 43.

Date, 1875	Name of star	Position of circle	Seconds of transit over the wires										Concluded chronometer time of transit over wire VI.	Level readings
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h. m. s.	p. p.
Feb. 11	δ Cancri	E	35·1	22·2	...	...	5·3	57·0	...	44·3	...	31·6	18·6	10 14 56·88	... ...
	ι Cancri	,,	11·7	57·9	...	..	39·5	30·1	...	...	...	...	...	10 16 30·17	+15·7 +38·0 / −10·9 −33·5
	ζ Hydræ	,,	45·35	33·0	...	...	...	8·8	...	56·8	...	44·4	32·3	10 26 8·78	−40·2 −17·7 / +37·0 +13·8
	ι Ursæ maj.	,,	56·9	38·5	...	20·1	...	2·0	...	43·9	...	...	...	10 28 1·99	−35·1 −12·0 / +32·6 +10·7
	Drac. 1 H.	,,	...	...	...	...	...	...	27·0	52·5	48·5	18·5	45·7	10 56 43·06	+14·2 +38·5 / −14·5 −38·0 / −37·0 −13·8 / +37·6 +14·0
	,, ,,	W	...	...	...	...	...	...	...	...	...	36·2	2·0	45·33	−36·8 −13·2 / +36·0 +12·2
	o Leonis	,,	13·9	26·0	...	...	...	50·8	...	3·0	...	15·3	27·8	11 11 50·78	... ...
	v Ursæ maj.	,,	...	...	...	...	14·4	30·5	46·3	...	...	18·2	42·1	11 19 30·42	+ 7·2 +31·0 / −10·6 −34·1
	η Leonis	,,	...	28·0	...	40·1	...	53·3	...	5·8	...	18·5	31·2	11 37 53·18	−32·3 − 8·5 / +35·2 +11·5
	λ Ursæ maj.	,,	6·8	23·3	...	...	...	56·5	...	13·2	...	30·0	46·9	11 46 56·71	... ...

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, DR. LÖW; CHRONOMETER NIEBERG.

Date, 1875	Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of transit over wire VI.			Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.					
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Feb. 18	γ Cassiopeiæ	W	...	...	11·3	...	27·8	...	59·9	...	...	32·0	56·0	4	34	43·71	+17·2	+38·3
																	−24·0	−45·2
																	+16·8	+37·7
																	−22·0	−43·0
	α Ursæ min.	„	39·0	23·0	...	...	...	18·0	...	...	...	...	...	4	58	19·53	−21·8	−43·0
																	+18·0	+38·9
																	−21·8	−42·8
																	+18·9	+39·7
	„ „	E	...	17·8	35·0	...	3·4	...	...	...	...	...	...			17·05	−21·7	−42·4
																	+20·0	+40·9
	β Arietis	„	46·2	33·3	...	20·4	...	7·6	...	54·3	...	...	28·9	5	33	7·48	+20·8	+42·0
																	−20·6	−41·8
	α Arietis	W	49·8	3·3	...	16·3	...	29·5	...	42·3	...	55·4	8·3	5	45	29·30	+18·2	+39·7
																	−22·3	−43·7
Feb. 19, 1st group	δ Ursæ min. S.P.	W	...	...	...	...	...	58·5	43·6	36·7	28·0	...	49·5	9	52	58·74	+17·8	+39·8
																	−23·9	−45·8
	„ „	E	...	...	...	...	...	...	...	27·0	36·5	52·5	13·5		53	5·40	−21·9	−44·5
																	+17·2	+40·1
	ε Geminorum	„	34·9	21·5	...	8·4	...	54·8	...	41·7	...	...	14·6	10	16	54·85	+16·8	+39·6
																	−20·1	−43·2
	θ Geminorum	„	55·9	41·5	...	26·8	...	11·8	...	57·8	...	42·9	28·6	10	25	12·16	−20·7	−43·7
																	+17·2	+40·3
	ζ Geminorum	W	40·3	53·4	...	6·2	...	19·4	...	31·7	...	44·8	57·8	10	37	19·11	−21·1	−44·3
																	+17·3	+40·3
	63 Aurigæ	„	...	9·0	...	24·3	...	40·1	...	55·5	...	11·4	27·2	10	43	40·14	+18·4	+41·6
																	−22·1	−45·4
	65 Aurigæ	„	31·2	46·5	...	1·3	...	16·6	...	31·3	...	46·7	1·7	10	54	16·50	−21·7	−44·9
																	+17·1	+40·4
	63 Geminorum	„	...	26·3	...	39·8	...	52·8	...	5·6	...	18·7	31·5	11	0	52·66	+17·0	+40·3
																	−21·0	−44·4
	f Geminorum	E	24·5	12·2	...	59·2	...	46·6	...	34·1	..	21·2	8·7	11	12	46·62	+17·6	+41·0
																	−19·7	−43·2
	π Geminorum	„	40·2	26·0	...	11·7	...	57·0	...	42·8	...	28·0	13·5	11	19	57·00	−21·7	−45·2
																	+17·7	+41·1
Feb. 19, 2nd group	Camel. 30 H.	E	...	...	...	...	...	...	51·5	18·0	44·3	36·0	53·8	13	55	59·14	+17·3	+42·0
																	−21·8	−46·3
	„ „	W	...	...	...	...	...	...	9·3	42·1	16·9	24·5	6·5		56	1·44	+16·0	+40·6
																	−21·9	−46·4
	42 Leonis min.	„	13·9	28·1	...	42·4	...	56·4	...	10·3	...	24·6	38·6	14	18	56·36	−20·9	−45·4
																	+15·4	+40·0
	46 Leonis min.	„	35·2	50·4	...	4·7	...	19·5	...	34·3	...	49·0	3·6	14	26	19·56	+15·9	+40·7
																	−22·0	−46·6
	ψ Ursæ maj.	E	26·8	9·5	58·5	...	47·1	35·8	24·2	...	12·8	1·6	44·0	14	42	35·57	[+16·1*	+41·9]
																	−20·9	−45·6
	ξ Ursæ maj.	„	9·2	54·9	...	40·1	...	26·4	...	12·5	...	58·4	43·4	14	51	26·39	−22·6	−47·3
																	+15·1	+39·9
	58 Ursæ maj.	„	29·5	12·6	1·3	...	50·6	39·3	28·2	...	17·1	5·7	49·0	15	3	39·24	+14·0	+39·0
																	−21·9	−46·9
	61 Ursæ maj.	„	4·1	49·3	39·6	...	29·9	19·8	10·3	...	0·2	50·7	35·8	15	14	19·95	...	...
	B.A.C. 4005	W	43·4	55·8	...	8·2	...	20·4	...	32·7	...	45·4	57·2	15	24	20·47	−22·1	−47·2
																	+13·9	+39·0
	1 Comæ	„	29·6	42·6	...	55·7	...	9·1	...	21·7	...	34·9	48·3	15	35	8·87	+14·4	+39·5
																	−22·8	−47·8
	Groom. 1852	„	...	...	33·2	52·0	10·4	...	26·2	44·0	3·0	...	...	15	38	48·27	−22·9	−47·9
																	+13·9	+39·0
Feb. 20, 1st group	δ Ursæ min. S.P.	W	...	...	...	...	...	59·3	43·5	37·5	28·0	12·3	48·5	9	48	58·76	+15·3	+38·2
																	−25·4	−48·2
	„ „	E	...	...	...	...	...	...	19·0	29·5	34·5	48·0	13·2		49	4·15	+16·3	+39·2
																	−22·3	−45·2
	ε Geminorum	„	37·3	23·9	...	10·8	...	57·4	...	...	...	...	17·3	10	12	57·34	−23·5	−46·5
																	+15·2	+38·2

[*] One reading is wrong by 1P·0; not used.

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, DR. LÖW; CHRONOMETER NIEBERG (*continued*).

Date, 1875	Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of transit over wire VI.			Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.					
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Feb. 20, 1st group (*cont.*)	θ Geminorum	E	58·3	43·8	...	29·2	...	14·5	...	0·4	...	45·7	30·9	10	21	14·66	+14·8	+37·7
																	−22·0	−45·0
	ζ Geminorum	W	42·9	55·5	...	8·2	...	21·4	...	34·4	...	47·2	0·2	10	33	21·42	+14·0	+37·0
																	−24·8	−47·8
	63 Aurigæ	„	...	...	...	27·1	...	42·5	...	57·7	...	13·8	29·7	10	39	42·57	−23·9	−46·9
																	+13·9	+37·0
	65 Aurigæ	„	33·3	48·4	...	3·7	...	18·8	...	33·8	...	49·1	4·3	10	50	18·80	+14·6	+37·6
																	−23·9	−46·9
	63 Geminorum	„	...	...	...	...	...	55·2	...	8·1	...	21·2	34·1	10	56	55·23	−24·2	−47·3
																	+15·1	+38·2
	f Geminorum	E	27·1	14·3	...	1·5	...	[48·2*]	...	36·7	...	23·4	10·9	11	8	48·96	−23·9	−46·9
																	+18·8	+41·9
	π Geminorum	„	43·1	...	...	14·1	...	59·4	...	45·2	...	30·5	15·9	11	15	59·50	+19·0	+42·0
																	−24·6	−47·7
	λ Ursæ min. S.P.	„	...	...	...	...	...	5·0	17·0	44·0	...	...	...	11	24	6·49	−23·2	−46·2
																	+16·5	+39·5
Feb. 20, 2nd group	*f* Leonis	E	9·5	55·4	...	41·3	...	27·2	...	...	...	...	...	13	12	27·35	+17·6	+40·3
																	−24·4	−47·3
	μ Leonis	„	31·8	18·1	...	5·1	...	51·3	...	38·2	...	24·7	10·9	13	21	51·42	−24·6	−47·3
																	+15·7	+38·5
	Piazzi IX. 230	„	40·2	27·4	...	14·0	...	1·1	...	...	43·6	35·0	22·0	13	32	1·08	+14·9	+37·7
																	−24·6	−47·5
	Piazzi IX. 254	„	24·7	8·4	57·9	...	47·3	36·4	25·5	...	15·0	4·4	48·2	13	39	36·41	−22·9	−45·7
																	+15·8	+38·5
	Camel. 30 H.	„	...	...	...	...	...	...	55·5	22·3	47·2	40·0	58·5	13	52	3·13	+16·8	+39·3
																	−22·3	−45·0
	„ „	W	...	...	...	...	...	...	12·4	46·1	20·1	29·5	...			5·28	[+14·7†	+37·3]
																	−25·0	−48·8
	33 Leonis min.	„	8·7	23·2	...	37·3	...	51·7	...	6·3	...	20·6	34·9	14	0	51·84	−25·7	−48·2
																	+13·7	+36·3
	42 Leonis min.	„	16·2	30·5	...	44·5	...	58·4	...	12·8	...	27·1	41·2	14	14	58·70	+14·0	+36·8
																	−24·8	−47·4
	46 Leonis min.	„	38·2	52·7	...	7·3	...	21·9	...	36·5	...	51·4	6·2	14	22	22·06	−23·2	−45·9
																	+13·3	+36·0
Feb. 23, 1st group	δ Ursæ min. S.P.	W	...	...	...	...	...	...	48·0	41·0	32·3	[12·5‡]	...	9	37	2·86	+18·9	+41·7
																	−19·2	−41·9
	„ „	E	...	...	...	...	...	8·8	23·5	29·5	39·3	54·5	...			8·44	+21·1	+43·9
																	−19·5	−42·2
	ε Geminorum	„	42·4	29·5	...	16·1	...	2·4	...	49·5	...	35·9	22·7	10	1	2·62	−18·8	−41·5
																	+19·1	+41·9
	θ Geminorum	„	3·4	49·2	...	34·7	...	20·1	...	5·7	...	50·8	36·2	10	9	19·99	+18·8	+41·7
																	−19·7	−42·3
	ζ Geminorum	„	5·3	52·3	...	39·5	...	26·4	...	13·5	...	0·4	47·7	10	21	26·42	−19·6	−42·8
																	+19·9	+43·0
	65 Aurigæ	W	39·4	54·3	...	9·2	...	24·6	...	39·3	...	54·7	9·8	10	38	24·50	−18·1	−41·5
																	+19·7	+43·1
	63 Geminorum	„	21·7	34·5	...	47·7	...	0·6	...	13·2	...	26·4	39·6	10	45	0·56	+18·9	+42·3
																	−18·8	−42·1
	f Geminorum	„	16·6	29·4	...	42·3	...	54·9	...	7·2	...	20·0	32·9	10	56	54·78	−18·6	−42·0
																	+20·4	+43·9
	π Geminorum	„	21·9	36·3	...	...	55·8	5·4	...	19·6	...	34·4	48·8	11	4	5·37	+20·1	+43·7
																	−17·4	−40·9
																	−17·7	−41·2
	λ Ursæ min. S.P.	„	...	...	...	39·0	9·0	52·0	...	...	...	...	...	11	11	55·15	+19·8	+43·3
																	+20·1	+43·8
																	−17·2	−41·0
Feb. 23, 2nd group	Camel. 30 H.	W	6·4	48·0	56·5	29·4	2·9	...	...	...	...	...	...	13	40	11·43	−18·2	−42·3
																	+20·1	+44·3
	„ „	E	14·2	32·0	24·0	50·7	17·3	...	...	...	...	...	...			8·85	−18·9	−43·2
																	+19·2	+43·4
	42 Leonis min.	„	46·3	32·0	...	17·9	...	3·9	...	49·8	...	35·7	...	14	3	3·84	+18·2	+42·6
																	−18·7	−43·1
	46 Leonis min.	„	11·4	56·5	...	41·9	...	27·2	...	12·7	...	57·8	43·0	14	10	27·19	−17·4	−41·9
																	+19·7	+44·1

[*] This wire discordant; rejected. [†] One level reading one part wrong; not used. [‡] Wire marked doubtful by observer; rejected.

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, DR. LÖW; CHRONOMETER NIEBERG (*continued*).

Date, 1875	Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of transit over wire VI.			Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.					
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Feb. 23, 2nd group (*cont.*)	ψ Ursæ maj.	E	35·2	17·5	6·7	...	55·2	43·8	32·4	...	21·2	9·7	52·6	14	26	43·80	+20·2	+44·7
																	−19·4	−43·9
	ξ Ursæ maj.*	„	...	3·1	...	48·8	...	34·6	...	20·4	...	5·9	51·9	14	35	34·54	−19·3	−43·9
																	+18·8	+43·2
	58 Ursæ maj.†	W	57·8	14·5	...	31·3	...	47·9	...	4·6	...	21·4	38·2	14	47	47·99	−19·0	−43·6
																	+17·2	+41·8
	61 Ursæ maj.	„	44·5	59·1	...	13·7	...	28·2	...	43·2	...	57·9	12·8	14	58	28·51	+20·2	+44·8
																	−19·4	−44·0
	1 Comæ	„	37·5	50·6	...	3·4	...	16·4	...	29·3	...	42·9	55·9	15	19	16·60	−18·9	−43·4
																	+18·8	+43·6
	Groom. 1852	„	...	...	...	...	19·3	56·8	34·7	53·0	11·8	49·4	...	15	22	57·12	+18·3	+43·1
																	−18·8	−43·3
Feb. 24	δ Ursæ min. S.P.	W	...	...	...	...	...	4·0	49·0	42·7	32·6	19·0	...	9	33	4·13	+17·8	+40·0
																	−21·0	−43·5
	„ „	E	...	...	...	...	...	...	25·0	31·0	41·5	55·0	20·0			9·83	+18·2	+41·0
																	−21·0	−43·8
	ε Geminorum	„	45·7	32·6	...	19·2	...	5·7	...	52·4	...	39·1	25·7	9	57	5·75	−19·7	−42·4
																	+17·9	+40·8
	θ Geminorum	„	6·5	52·2	...	37·5	...	23·2	...	8·5	...	54·0	39·4	10	5	23·02	+17·5	+40·3
																	−21·7	−44·8
	63 Aurigæ	„	37·4	21·9	...	6·2	...	50·6	...	35·3	...	19·4	3·8	10	23	50·63	−21·2	−44·2
																	+17·7	+40·8
	63 Geminorum	W	24·2	...	...	50·4	...	3·4	...	16·4	...	29·3	42·1	10	41	3·34	−20·8	−44·0
																	+16·9	+40·2
	f Geminorum	„	...	...	...	45·2	...	57·3	...	10·4	...	23·4	36·1	10	52	57·84	+17·7	+40·9
																	−21·9	−45·2
Feb. 25	δ Ursæ min. S.P.	W	...	...	...	...	...	6·2	51·3	44·5	35·0	20·0	55·3	9	29	5·94	−22·7	−44·8
																	+15·5	+38·0
	„ „	E	...	...	...	...	...	...	26·2	32·0	41·0	57·0	21·5			10·87	−20·9	−43·6
																	+17·4	+40·2
	ε Geminorum	„	47·5	34·3	...	21·2	...	7·7	...	54·3	...	41·0	27·6	9	53	7·63	+18·9	+41·8
																	−22·0	−45·1
	θ Geminorum	„	8·4	54·3	...	39·4	...	24·7	...	10·6	...	55·8	41·2	10	1	24·89	−21·5	−44·7
																	+16·1	+39·2
	ζ Geminorum	„	10·2	57·2	...	44·3	...	31·5	...	18·4	...	6·0	52·8	10	13	31·46	...	...
	63 Aurigæ	„	39·5	23·9	13·7	...	3·2	52·2	42·4	...	31·8	...	5·8	10	19	52·64	+17·4	+40·7
																	−20·8	−44·0
	65 Aurigæ	W	...	...	...	...	...	29·6	...	44·4	...	59·6	14·7	10	30	29·48	+16·9	+40·2
																	−22·0	−45·2
	63 Geminorum	„	26·6	39·5	...	52·5	...	5·5	...	18·4	...	31·5	44·3	10	37	5·50	−21·9	−45·2
																	+17·6	+41·2
	f Geminorum	„	21·8	34·3	...	47·0	...	59·7	...	12·3	...	25·1	37·8	10	48	59·74	+16·3	+40·0
																	−20·6	−44·1
	π Geminorum	„	[29·2‡]	41·4	...	56·2	...	10·4	...	24·7	...	39·7	54·2	10	56	10·55	−21·2	−44·9
																	+17·0	+40·8
	λ Ursæ min. S.P.	„	...	...	14·0	40·0	9·5	48·8	...	...	...	...	...	11	3	55·37	+17·3	+41·1
																	−21·0	−44·9

* In accordance with observer's note, wires II., IV., and VI. have each been lessened 1ˢ.

† In accordance with observer's note, each wire has been lessened 2ˢ, [‡] This wire discordant; rejected.

The Instrumental Corrections of Dr. Löw's Transit Instrument.

The value of one part of the level is 0ˢ·111; there is a further correction required to the mean level for inequality of the pivots of the instrument of +0ᵖ·15 for circle E, and −0ᵖ·15 for circle W.

On February 11 the tube of the level was found to be loose in its mounting, owing to one of the cork wedges having got out of place; this will probably account for the previous

levellings not being as accordant as could be desired. Under these circumstances the mean of the East and West levellings of each group of observations has been used for that group, except when there was only a single levelling in one of the positions; in which case each levelling has been corrected for inequality of pivots before taking the mean.

Levellings.

1875, JANUARY 30.

E	W
p.	p.
+3·40	+3·18
−0·65	+1·02
+4·98	+2·40
+0·82	
+2·85	

	p.
Mean level	+2·24

	p.	s.
E	+2·39	= +0·265
W	+2·09	= +0·232

1875, JANUARY 31.

1st Group.

E	W
p.	p.
−4·20	−3·22
−1·78	−3·82
−6·28	−3·18
−2·70	−3·58
−3·32	−1·28
−1·48	
−5·02	
−3·20	

	p.
Mean level	−3·26

	p.	s.
E	−3·11	= −0·345
W	−3·41	= −0·379

2nd Group.

E	W
p.	p.
−5·45	−0·45
−1·18	−3·08
+1·05	−3·60
−5·40	−2·02

	p.
Mean level	−2·52

	p.	s.
E	−2·37	= −0·263
W	−2·67	= −0·296

3rd Group.

E	W
p.	p.
−0·05	+3·10
−1·30	−3·45

	p.
Mean level	−0·42

	p.	s.
E	−0·27	= −0·030
W	−0·57	= −0·063

4th Group.

E	W
p.	p.
+1·58	−2·50
	+0·82
	−1·15

	p.
Mean level	−0·16

	p.	s.
E	−0·01	= −0·001
W	−0·31	= −0·034

1875, FEBRUARY 5.

E	W
p.	p.
−2·42	+2·65
+3·08	−4·68
+1·02	+4·55
+1·42	−1·62
+1·35	
+0·58	

	p.
Mean level	+0·53

	p.	s.
E	+0·68	= +0·075
W	+0·38	= +0·042

1875, FEBRUARY 6.

E	W
p.	p.
−3·45	−3·38
+0·60	−3·98
+1·30	−1·45
−1·12	−0·98
	−1·52

	p.
Mean level	−1·46

	p.	s.
E	−1·31	= −0·145
W	−1·61	= −0·179

1875, FEBRUARY 7.

E	W
p.	p.
+1·05	−2·82
+2·95	−0·20
+3·42	−1·58
+1·02	+2·78
+0·98	+0·05
	+0·85

	p.
Mean level	+0·87

	p.	s.
E	+1·02	= +0·113
W	+0·72	= +0·080

1875, FEBRUARY 8.

E	W
p.	p.
+4·12	+0·92
−0·75	+0·85
−1·28	−0·20
+2·18	+0·98
+1·10	

	p.	s.
Mean level	+0·86	
E	+1·01 =	+0·112
W	+0·71 =	+0·079

1875, FEBRUARY 9.

1st Group.

E	W
p.	p.
−3·08	−1·58
−3·15	+0·98
+0·92	−1·15
−2·58	+0·15
−2·08	+2·62
+2·20	

	p.	s.
Mean level	−0·55	
E	−0·40 =	−0·044
W	−0·70 =	−0·078

2nd Group.

E	W
p.	p.
−2·58	−0·15
+1·45	−1·58
−0·75	+0·28
+3·28	−2·42
	−1·02
	−0·92
	−1·38

	p.	s.
Mean level	−0·34	
E	−0·19 =	−0·021
W	−0·49 =	−0·054

1875, FEBRUARY 11.

Mean level (by reversing the instrument with the level on it).

p.
+2·32
−1·78
−0·95
+0·05
+0·20
−0·45
−1·62
+1·48

	p.	s.
Mean level	−0·09	
E	+0·06 =	+0·007
W	−0·24 =	−0·027

1875, FEBRUARY 18.

E	W
p.	p.
−0·80	−3·42
+0·10	−1·98
	−1·50
	−2·62
	−2·02

	p.	s.
Mean level	−1·33	
E	−1·18 =	−0·131
W	−1·48 =	−0·164

1875, FEBRUARY 19.

1st Group.

E	W
p.	p.
−2·28	−3·02
−1·72	−1·95
−1·72	−1·88
−1·08	−2·28
−2·02	−2·02

	p.	s.
Mean level	−2·00	
E	−1·85 =	−0·205
W	−2·15 =	−0·239

2nd Group.

E	W
p.	p.
−2·20	−2·92
−3·72	−2·72
−3·95	−3·00
	−4·10
	−4·18
	−4·48

	p.	s.
Mean level	−3·43	
E	−3·28 =	−0·364
W	−3·58 =	−0·397

1875, FEBRUARY 20.

1st Group.

E	W
p.	p.
−3·00	−5·02
−4·15	−5·40
−3·62	−4·98
−2·52	−4·65
−2·82	−4·55
−3·35	

	p.	s.
Mean level	−4·08	
E	−3·93 =	−0·436
W	−4·23 =	−0·470

2nd Group.

E	W
p.	p.
−3·45	−5·98
−4·42	−5·35
−4·88	−4·95
−3·58	
−2·80	

	p.	s.
Mean level	−4·63	
E	−4·48 =	−0·497
W	−4·78 =	−0·531

1875, FEBRUARY 23.

1st Group. E	W		*2nd Group.* E	W	
p.	p.		p.	p.	
+0·82	−0·12		+0·12	+0·98	
+0·18	+0·80		−0·25	−0·90	Mean level +0·14
−0·38	+0·08		+1·12	+0·40	p. s.
+0·12	+0·92	Mean level +0·49	+0·40	+0·02	E +0·29 = +0·032
	+1·38	p. s.	−0·30	−0·18	W −0·01 = −0·001
	+1·05	E +0·64 = +0·071			
	+1·42	W +0·34 = +0·038			

1875, FEBRUARY 24.

E	W	
p.	p.	
−1·40	−1·68	Mean level −1·72
−0·85	−1·92	p. s.
−2·18	−2·12	E −1·57 = −0·174
−1·72		W −1·87 = −0·208

1875, FEBRUARY 25.

E	W	
p.	p.	
−1·72	−3·50	
−1·60	−2·52	
−2·72	−2·08	Mean level −2·14
−1·68	−2·10	p. s.
	−2·08	E −1·99 = −0·221
	−1·88	W −2·29 = −0·254

The correction for collimation was deduced from the observations of pole stars made in both positions of the instrument; the azimuth correction by combining the various pole stars with the time stars; when more than one star was observed, the mean of the results has been taken, using the collimation and azimuth factors respectively as weights. These corrections are :—

Date, 1875	Collimation, circle W	Azimuth
	s.	s.
Jan. 30	−0·306	+6·685
„ 31, 1st group	−0·310	+0·901
„ 31, 2nd „	−0·324	+1·212
„ 31, 3rd „	„	+1·316
„ 31, 4th „	„	+1·340
Feb. 5	−0·369	−0·103
„ 6	−0·334	−0·409
„ 7	−0·316	+0·372
„ 8	−0·424	+0·806
„ 9, 1st group	−0·278	+0·740
„ 9, 2nd „	−0·376	+0·697
„ 11	−0·150	+0·964
„ 18	−0·021	+1·160
„ 19, 1st group	−0·191	+0·324
„ 19, 2nd „	−0·127	+0·133
„ 20, 1st „	−0·153	+0·430
„ 20, 2nd „	−0·117	+0·271
„ 23, 1st „	−0·159	+0·782
„ 23, 2nd „	−0·143	+0·591
„ 24	−0·162	+0·851
„ 25	−0·139	+0·780

The chronometer 'Nieberg' was a mean-time chronometer, but in reducing the observation it was found more convenient to treat it as a sidereal chronometer. This was done by taking

the mean of the times of observation in each group to the nearest exact minute, and with an assumed rate reducing all the times to this epoch. The detailed reductions are given in the next table :—

OBSERVER, DR. LÖW; CHRONOMETER NIEBERG.

Date, 1875	Epoch by chronometer and assumed *hourly* chronometer rate	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Chronometer rate to epoch	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m. s.			h. m. s.	s.	s.	h. m. s.	h. m. s.
Jan. 30	19 43 0·00	α Boötis	W	19 8 48·79	−5·66	+ 1·17	14 9 57·92	−4 58 46·38
	s.	ϕ Virginis	„	19 20 32·36	−3·72	+ 3·39	14 21 45·90	46·13
	+9·938	ρ Boötis	„	19 25 16·38	−2·93	− 0·21	14 26 26·91	46·33
		π^1 Boötis	E	19 33 36·81	−1·55	+ 2·16	14 34 51·23	46·19
		ϵ Boötis	„	19 38 17·92	−0·78	+ 0·96	14 39 31·86	46·24
		α Libræ	„	19 42 38·40	−0·06	+ 5·46	14 43 57·75	46·05
		β Ursæ min.	„	19 50 7·67	+1·18	−15·89	14 51 6·56	[46·40]
		ψ Boötis	„	19 57 48·22	+2·45	+ 0·98	14 59 5·42	46·23
		δ Boötis	W	20 9 10·50	+4·34	− 0·62	15 10 27·88	46·34
		11 Ursæ min.	„	20 16 9·12	+5·49	−15·21	15 17 13·03	[46·38]
		„ „	E	7·03	+5·49	−13·13	„	
		γ Ursæ min.	„	20 19 50·00	+6·10	−13·13	15 20 57·07	[45·90]
		α Coronæ	„	20 28 1·10	+7·46	+ 1·01	15 29 23·59	45·98
	h. m. s.							
Jan. 31, 1st group	9 5 0·00	Groom. 2283 S.P.	E	8 14 45·43	−8·32	+16·18	15 18 19·28	[−4 56 34·12]
	s.	„ „	W	29·84	−8·37	+32·03	„	
	+9·938	ϵ Eridani	„	8 23 42·99	−6·84	− 0·02	3 27 2·83	−4 56 33·30
		10 Tauri	„	8 27 9·58	−6·27	− 0·19	3 30 30·02	33·10
		Camel. 5 H.	„	8 33 53·85	−5·15	− 3·64	3 37 11·82	[33·24]
		31 Tauri	„	8 41 58·07	−3·81	− 0·29	3 45 20·73	33·24
		Lacaille 1273	„	8 45 44·27	−3·19	+ 0·28	3 49 8·32	33·04
		Groom. 750	„	8 54 50·82	−1·69	−15·23	3 58 0·55	[32·85]
		„ „	E	42·13	−1·70	− 7·53	„	
		o^1 Eridani	„	9 2 19·29	−0·44	+ 0·58	4 5 46·40	33·03
		γ Tauri	„	9 9 13·60	+0·70	+ 0·21	4 12 41·34	33·17
		δ Tauri	„	9 12 15·58	+1·20	+ 0·18	4 15 44·11	32·85
		ϵ Tauri	„	9 17 50·28	+2·13	+ 0·15	4 21 19·64	32·92
		Groom. 848	„	9 28 35·69	+3·91	− 2·34	4 32 4·68	[32·58]
		μ Eridani	„	9 35 43·37	+5·09	+ 0·52	4 39 15·92	33·06
		π^4 Orionis	„	9 41 0·33	+5·96	+ 0·38	4 44 33·62	33·05
		π^5 Orionis	„	9 44 11·30	+6·50	+ 0·42	4 47 45·13	33·09
		ϵ Ursæ min. S.P.	„	9 55 4·52	+8·30	+ 4·85	16 58 46·19	[31·88]
		„ „	W	0·66	+8·29	+ 9·52	„	
	h. m. s.							
Jan. 31, 2nd group	11 35 0·00	ν Orionis	W	10 56 42·38	−6·34	− 0·30	6 0 27·17	−4 56 8·57
	s.	η Geminorum	„	11 3 35·38	−5·20	− 0·50	6 7 21·06	8·62
	+9·938	δ Ursæ min. S. P.	„	11 8 7·46	−4·45	+25·99	18 12 21·01	[7·99]
		μ Geminorum	„	11 11 38·01	−3·87	− 0·50	6 15 25·07	8·57
		γ Geminorum	„	11 26 40·71	−1·38	− 0·35	6 30 30·59	8·39
		15 Monocerotis	„	11 30 16·08	−0·79	− 0·19	6 34 6·82	8·28
		ξ Geminorum	„	11 34 26·35	−0·09	− 0·26	6 38 17·58	8·42
		Cephei 51 H.	„	11 38 19·28	+0·55	−31·22	6 41 41·28	[7·34]
		„ „	E	5·50	+0·51	−17·39	„	

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, DR. LÖW; CHRONOMETER NIEBERG (*continued*).

Date, 1875	Epoch by chronometer and assumed *hourly* chronometer rate	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Chronometer rate to epoch	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m. s.			h. m. s.	s.	s.	h. m. s.	h. m. s.
Jan. 31, 2nd group (*cont.*)	11 35 0·00 s. +9·938	52 Geminorum	E	12 3 8·12	+ 4·66	+ 0·18	7 7 4·69	−4 56 8·27
		ι Geminorum	„	12 14 0·90	+ 6·46	+ 0·11	7 17 59·22	8·25
		β Canis min.	„	12 16 24·50	+ 6·86	+ 0·53	7 20 23·56	8·33
		Groom. 2900 S.P.	„	12 24 59·49	+ 8·28	+ 4·91	19 29 4·93	[7·75]
Jan. 31, 3rd group	h. m. s. 17 35 0·00 s. +9·938	Drac. 4 H.	E	17 1 42·58	− 5·52	− 3·35	12 6 25·96	[−4 55 7·75]
		η Virginis	„	17 8 43·20	− 4·36	+ 0·95	12 13 31·40	−4 55 8·39
		B.A.C. 4165	W	17 11 11·49	− 3·94	−52·54	12 15 6·30	[8·71]
		δ Virginis	„	17 44 25·45	+ 1·56	+ 0·20	12 49 19·12	8·09
		ε Virginis	„	17 51 3·50	+ 2·66	+ 0·03	12 55 57·97	8·22
Jan. 31, 4th group	h. m. s. 19 23 0·00 s. +9·938	κ Virginis	W	19 1 7·34	− 3·62	+ 0·51	14 6 13·88	−4 54 50·35
		4 Ursæ min.	„	19 4 25·19	− 3·08	− 6·53	14 9 25·24	[50·34]
		φ Virginis	„	19 16 36·88	− 1·06	+ 0·35	14 21 45·93	50·24
		ρ Boötis	„	19 21 18·00	− 0·28	− 0·44	14 26 26·95	50·33
		π^1 Boötis	E	19 29 39·85	+ 1·10	+ 0·65	14 34 51·26	50·34
		ε Boötis	„	19 34 19·97	+ 1·88	+ 0·43	14 39 31·90	50·38
		α Libræ	„	19 38 44·19	+ 2·61	+ 1·33	14 43 57·78	50·35
		β Ursæ min.	„	19 45 55·52	+ 3·80	− 2·34	14 51 6·65	[50·33]
Feb. 5	h. m. s. 18 56 0·00 s. +10·008	α Ursæ min. S.P.	E	17 47 41·39	−11·39	−21·01	1 12 11·23	[−4 34 57·76]
		„ „	W	9·49	−11·48	+10·98	„	
		η Ursæ maj.	„	18 17 43·35	− 6·39	− 0·46	13 42 38·15	−4 34 58·35
		η Boötis	„	18 23 48·85	− 5·37	− 0·37	13 48 44·59	58·52
		τ Virginis	„	18 30 20·34	− 4·27	− 0·38	13 55 17·56	58·13
		α Boötis	„	18 44 58·84	− 1·84	− 0·37	14 9 58·11	58·52
		ρ Boötis	E	19 1 23·72	+ 0·90	+ 0·52	14 26 27·12	58·02
		109 Virginis	„	19 14 50·96	+ 3·15	+ 0·39	14 39 56·01	58·49
		β Boötis	„	19 32 6·45	+ 6·02	+ 0·62	14 57 14·69	58·40
		β Libræ	„	19 45 6·85	+ 8·19	+ 0·36	15 10 16·85	58·55
		γ Ursæ min.	„	19 55 43·70	+ 9·96	+ 1·62	15 20 57·53	[57·75]
Feb. 6	h. m. s. 7 13 0·00 s. +9·986	α Ursæ min.	E	5 44 56·34	−14·66	+25·77	1 12 12·26	[−4 32 55·19]
		„ „	W	45 25·32	−14·58	− 3·29	„	
		β Arietis	„	6 20 48·62	− 8·68	− 0·62	1 47 43·66	−4 32 55·66
		γ Andromedæ	E	6 29 15·44	− 7·28	+ 0·37	1 56 13·05	55·48
		α Arietis	„	6 33 9·07	− 6·64	+ 0·15	2 0 7·27	55·31
		δ Ceti	„	7 6 1·22	− 1·17	− 0·01	2 33 4·53	55·51
		41 Arietis	„	7 15 32·40	+ 0·42	+ 0·18	2 42 37·46	55·54
		β Ursæ min. S.P.	„	7 24 2·97	+ 1·83	− 2·62	14 51 7·01	[55·17]
		β Persei	W	7 32 55·24	+ 3·31	− 0·57	3 0 2·16	55·82
		α Persei	„	7 48 14·54	+ 5·87	− 0·56	3 15 24·15	55·70
		ξ Tauri	„	7 53 13·64	+ 6·70	− 0·66	3 20 23·72	55·96
		f Tauri	„	7 56 47·68	+ 7·29	− 0·64	3 23 58·55	55·78

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, DR. LÖW; CHRONOMETER NIEBERG (*continued*).

Date, 1875	Epoch by chronometer and assumed *hourly* chronometer rate	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Chronometer rate to epoch	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m. s.			h. m. s.	s.	s.	h. m. s.	h. m. s.
Feb. 7	5 41 0·00	*a* Andromedæ	W	4 31 18·21	−11·55	− 0·26	0 1 54·46	−4 29 11·94
	s.	*a* Cassiopeiæ	,,	5 2 42·53	− 6·34	− 0·72	0 33 23·29	12·18
	+9·940	*β* Ceti	,,	5 6 35·88	− 5·70	+ 0·02	0 37 18·23	11·97
		γ Cassiopeiæ	,,	5 18 24·82	− 3·74	− 0·86	0 49 8·35	11·87
		β Andromedæ	,,	5 31 56·71	− 1·50	− 0·33	1 2 43·19	11·69
		a Ursæ min.	,,	5 41 48·08	+ 0·13	−25·09	1 12 11·31	[11·81]
		,, ,,	E	20·64	+ 0·06	+ 2·42	,,	
		β Arietis	,,	6 16 48·79	+ 5·93	+ 0·53	1 47 43·65	−4 29 11·60
		γ Andromedæ	,,	6 25 16·90	+ 7·33	+ 0·47	1 56 13·03	11·67
		a Arietis	,,	6 29 10·36	+ 7·98	+ 0·51	2 0 7·25	11·60
		β Trianguli	,,	6 31 8·90	+ 8·31	+ 0·49	2 2 5·92	11·78
	h. m. s.							
	10 11 0·00	*ε* Ursæ min. S.P.	E	9 23 22·42	− 7·90	+ 2·07	16 58 47·30	[−4 24 29·29]
	s.	,, ,,	W	16·07	− 7·92	+ 8·44	,,	
	+9·956	*β* Tauri	,,	9 42 58·54	− 4·65	− 0·37	5 18 24·27	−4 24 29·25
		122 Tauri	,,	9 54 21·61	− 2·76	− 0·17	5 29 49·38	29·30
		o Aurigæ	,,	10 0 46·05	− 1·70	− 0·96	5 36 14·32	29·07
		χ^2 Orionis	E	10 12 2·00	+ 0·17	+ 0·72	5 47 33·68	29·21
		66 Orionis	,,	10 22 49·47	+ 1·96	+ 0·88	5 58 23·11	29·20
		δ Ursæ min. S.P.	,,	10 36 43·36	+ 4·27	+ 4·16	18 12 22·64	[29·15]
		51 Aurigæ	,,	10 54 22·71	+ 7·20	+ 0·52	6 30 1·16	29·27
	h. m. s.							
Feb. 9, 1st group	5 25 0·00	*a* Andromedæ	E	4 23 21·62	−10·17	+ 0·29	0 1 54·44	−4 21 17·30
	s.	*a* Cassiopeiæ	,,	4 54 45·56	− 4·99	− 0·15	0 33 23·24	17·18
	+9·898	*γ* Cassiopeiæ	,,	5 10 28·24	− 2·40	− 0·26	0 49 8·29	17·29
		β Andromedæ	,,	5 24 0·12	− 0·16	+ 0·21	1 2 43·16	17·01
		a Ursæ min.	,,	5 33 41·25	+ 1·44	−15·96	1 12 9·52	[17·22]
		,, ,,	W	34 5·55	+ 1·50	−40·31	,,	
		γ Andromedæ	,,	6 17 22·24	+ 8·64	− 0·67	1 56 12·99	17·22
		a Arietis	,,	6 21 15·48	+ 9·28	− 0·28	2 0 7·23	17·25
	h. m. s.							
Feb. 9, 2nd group	12 0 0·00	*δ* Ursæ min. S.P.	W	10 32 31·31	−14·43	+17·27	18 12 22·92	[−4 20 11·23]
	s.	Cephei 51 H.	,,	11 2 20·91	− 9·51	−20·61	6 41 39·57	[11·22]
	+9·898	,, ,,	E	4·95	− 9·55	− 4·60	,,	
		64 Aurigæ	,,	11 29 38·82	− 5·01	+ 0·29	7 9 22·21	−4 20 11·89
		56 Geminorum	,,	11 34 51·16	− 4·15	+ 0·50	7 14 35·68	11·83
		68 Geminorum	W	11 46 44·38	− 2·19	− 0·27	7 26 29·74	12·18
		o Geminorum	,,	11 51 16·07	− 1·44	− 0·60	7 31 1·94	12·09
		26 Lyncis	,,	12 5 50·35	+ 0·96	− 0·96	7 45 38·38	11·97
		ω^2 Cancri	,,	12 14 22·89	+ 2·37	− 0·42	7 54 12·90	11·94
		Piazzi VII. 321	E	12 23 57·52	+ 3·96	+ 0·39	8 3 50·36	11·51
		χ Cancri	,,	12 32 35·79	+ 5·37	+ 0·43	8 12 29·89	11·70

THE OBSERVATIONS WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH. OBSERVER, MR. GILL; CHRONOMETER 43.

As a Transit Instrument.

LEVELLINGS.

Circle E.

	Level correction s.
α Andromedæ	−0·320
α Cassiopeiæ	−0·195
γ Cassiopeiæ	−0·181
β Andromedæ	−0·067
α Ursæ min.	−0·031

Circle W.

	Level correction s.
α Ursæ min.	+0·209
β Arietis	+0·255
γ Andromedæ	+0·387
α Arietis	(+0·298)
β Trianguli	+0·209

For α Arietis there was no determination of level correction; the mean of the levellings for γ Andromedæ and β Trianguli has been used for this star.

The correction for collimation was found by successive approximations to be—

s.
−0·715 for circle W.

With these corrections, combining the observations of α Ursæ minoris East and West separately with the time stars observed in the same position of the instrument, the azimuth corrections are :—

s.
+10·203, Circle E.

s.
+10·376, Circle W.

Whence—

Date, 1875	Epoch by chronometer and assumed *hourly* chronometer rate	Name of star	Position of circle	Concluded chronometer time of transit over wire III.	Chronometer rate to epoch	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m.			h. m. s.	s.	m. s.	h. m. s.	h. m. s.
Feb. 9, 1st group	2 54 s. +0·082	α Andromedæ	E	1 39 17·45	−0·10	+0 0·78	0 1 54·44	−1 37 23·69
		α Cassiopeiæ	„	2 10 54·01	−0·06	−0 6·99	0 33 23·24	23·72
		γ Cassiopeiæ	„	2 26 41·38	−0·04	−0 9·12	0 49 8·29	23·93
		β Andromedæ	„	2 40 7·40	−0·02	−0 0·29	1 2 43·16	23·93
		α Ursæ min.	„	2 55 13·16	0·00	−5 39·72	1 12 9·52	[23·82]
		„ „	W	2 56 14·89	0·00	−6 41·46	1 12 9·52	[23·91]
		β Arietis	„	3 25 6·06	+0·04	+0 1·39	1 47 43·62	23·87
		γ Andromedæ	„	3 33 40·40	+0·05	−0 3·28	1 56 12·99	24·18
		α Arietis	„	3 37 30·06	+0·06	+0 0·93	2 0 7·23	23·82
		β Trianguli	„	3 39 31·20	+0·06	−0 1·62	2 2 5·89	23·79

OBSERVATIONS OF TIME STARS IN THE VERTICAL OF A POLE STAR. c = −0ˢ·526

Date, 1875	Epoch by chronometer and assumed *hourly* chronometer rate	Name of star	Position of circle	C	Concluded chronometer time of transit over wire III.	R.A. of star, including daily aberration	Rate of chronometer to epoch	t−m	Cc	Chronometer correction
	h. m.			s.	h. m. s.	h. m. s.	s.	m s.	s.	h. m. s.
Feb. 9, 2nd group	9 27 s. +0·082	68 Geminorum	E	+1·329	9 2 19·28	7 26 29·74	+0·03	−1 33·46	−0·70	−1 37 23·67
		o Geminorum	„	+1·099	9 9 3·96	7 31 1·94	+0·02	+0 38·91	−0·58	23·67
		ω² Cancri	„	+1·209	9 31 3·23	7 54 12·90	−0·01	−0 32·84	−0·64	23·82
		Piazzi VII. 321	W	−1·222	9 41 36·08	8 3 50·36	−0·02	+0 21·39	+0·59	23·76
		κ Cancri	„	−1·182	9 49 36·81	8 12 29·89	−0·03	−0 17·35	+0·62	23·68

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, MR. GILL; CHRONOMETER 43.

Date, 1875	Epoch by chronometer and assumed *hourly* chronometer rate	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Chronometer rate to epoch	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m.			h. m. s.	s.	s.	h. m. s.	h. m. s.
Feb. 11	10 55	δ Cancri	E	10 14 56·88	−0·06	+0·37	8 37 36·35	−1 37 20·84
	s.	ι Cancri	„	10 16 30·17	−0·06	+0·19	8 39 9·54	20·76
	+0·088	ζ Hydræ	„	10 26 8·78	−0·04	+0·55	8 48 48·58	20·71
		ι Ursæ maj.	„	10 28 1·99	−0·04	−0·22	8 50 40·93	20·80
		Drac. 1 H.	„	10 56 43·06	0·00	−4·28	9 19 18·02	} [20·76]
		„		45·33	0·00	−6·55	„	
		o Leonis	W	11 11 50·78	+0·02	+0·15	9 34 30·16	20·79
		v Ursæ maj.	„	11 19 30·42	+0·04	−1·29	9 42 8·58	20·59
		η Leonis	„	11 37 53·18	+0·06	+0·03	10 0 32·53	20·74
		λ Ursæ maj.	„	11 46 56·71	+0·08	−0·56	10 9 35·38	20·85

OBSERVER, DR. LÖW; CHRONOMETER NIEBERG.

Date, 1875	Epoch by chronometer and assumed *hourly* chronometer rate	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Chronometer rate to epoch	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m. s.			h. m. s.	s.	s.	h. m. s.	h. m. s.
Feb. 18	5 18 0·00	γ Cassiopeiæ	W	4 34 43·71	− 7·16	− 1·48	0 49 8·05	−3 45 27·02
	s.	*a* Ursæ min.	„	4 58 19·53	− 3·25	−46·49	1 12 3·02	} [26·76]
	+9·930	„	E	17·05	− 3·26	−44·01	„	
		β Arietis	„	5 33 7·48	+ 2·50	+ 0·09	1 47 43·51	26·56
		a Arietis	W	5 45 29·30	+ 4·55	− 0·04	2 0 7·10	26·71
	h. m. s.							
Feb. 19, 1st group	10 49 0·00	δ Ursæ min. S.P.	W	9 52 58·74	− 9·27	+ 9·91	18 12 25·53	} [−3 40 33·84]
	s.	„	E	53 5·40	− 9·25	+ 3·22	„	
	+9·930	ε Geminorum	„	10 16 54·85	− 5·31	+ 0·01	6 36 15·60	−3 40 33·95
		θ Geminorum	„	10 25 12·16	− 3·94	− 0·05	6 44 34·27	33·90
		ζ Geminorum	W	10 37 19·11	− 1·93	− 0·39	6 56 42·90	33·89
		63 Aurigæ	„	10 43 40·14	− 0·88	− 0·63	7 3 4·88	33·75
		65 Aurigæ	„	10 54 16·50	+ 0·87	− 0·59	7 13 42·95	33·83
		63 Geminorum	„	11 0 52·66	+ 1·96	− 0·41	7 20 20·47	33·74
		f Geminorum	E	11 12 46·62	+ 3·94	+ 0·06	7 32 16·72	33·90
		π Geminorum	„	11 19 57·00	+ 5·12	− 0·05	7 39 28·31	33·76
	h. m. s.							
Feb. 19, 2nd group	14 57 0·00	Camel. 30 H.	E	13 55 59·14	−10·10	− 1·67	10 15 54·68	} [−3 39 52·69]
	s.	„	W	56 1·44	−10·09	− 3·98	„	
	+9·930	42 Leonis min.	„	14 18 56·36	− 6·30	− 0·61	10 38 56·60	−3 39 52·85
		46 Leonis min.	„	14 26 19·56	− 5·08	− 0·64	10 46 21·06	52·78
		ψ Ursæ maj.	E	14 42 35·57	− 2·39	− 0·37	11 2 40·22	52·59
		ξ Ursæ maj.	„	14 51 26·39	− 0·92	− 0·29	11 11 32·52	52·66
		58 Ursæ maj.	„	15 3 39·24	+ 1·10	− 0·35	11 23 47·30	52·69
		61 Ursæ maj.	„	15 14 19·95	+ 2·87	− 0·30	11 34 29·90	52·62
		B.A.C. 4005	W	15 24 20·47	+ 4·52	− 0·48	11 44 31·82	52·69
		1 Comæ	„	15 35 8·87	+ 6·32	− 0·55	11 55 21·65	52·99
		Groom. 1852	„	15 38 48·27	+ 6·92	− 2·30	11 59 0·12	[52·77]

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, DR. LÖW; CHRONOMETER NIEBERG (*continued*).

Date, 1875	Epoch by chronometer and assumed *hourly* chronometer rate	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Chronometer rate to epoch	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m. s.			h. m. s.	s.	s.	h. m. s.	h. m. s.
Feb. 20, 1st group	10 45 0·00 s. +9·916	δ Ursæ min. S.P.	W	9 48 58·76	− 9·26	+12·61	18 12 25·83	[−3 36 36·28]
		,,	E	49 4·15	− 9·25	+ 7·20	,,	
		ε Geminorum	,,	10 12 57·34	− 5·29	− 0·27	6 36 15·59	−3 36 36·19
		θ Geminorum	,,	10 21 14·66	− 3·92	− 0·39	6 44 34·25	36·10
		ζ Geminorum	W	10 33 21·42	− 1·92	− 0·59	6 56 42·89	36·02
		63 Aurigæ	,,	10 39 42·57	− 0·87	− 0·89	7 3 4·87	35·94
		65 Aurigæ	,,	10 50 18·80	+ 0·88	− 0·84	7 13 42·94	35·90
		63 Geminorum	,,	10 56 55·23	+ 1·97	− 0·59	7 20 20·46	36·15
		f Geminorum	E	11 8 48·96	+ 3·93	− 0·20	7 32 16·71	35·98
		π Geminorum	,,	11 15 59·50	+ 5·12	− 0·37	7 39 28·30	35·95
		λ Ursæ min. S.P.	,,	11 24 6·49	+ 6·46	+23·19	19 48 0·36	[35·78]
Feb. 20, 2nd group	h. m. s. 13 47 0·00 s. +9·916	f Leonis	E	13 12 27·35	− 5·71	− 0·44	9 36 15·39	−3 36 5·81
		μ Leonis	,,	13 21 51·42	− 4·16	− 0·40	9 45 40·90	5·96
		Piazzi IX. 230	,,	13 32 1·08	− 2·47	− 0·36	9 55 52·42	5·83
		Piazzi IX. 254	,,	13 39 36·41	− 1·22	− 0·56	10 3 28·76	5·87
		Camel. 30 H.	,,	13 52 3·13	+ 0·84	− 3·35	10 15 54·71	[5·91]
		,,	W	5·28	+ 0·84	− 5·50	,,	
		33 Leonis min.	,,	14 0 51·84	+ 2·29	− 0·79	10 24 47·43	5·91
		42 Leonis min.	,,	14 14 58·70	+ 4·63	− 0·77	10 38 56·61	5·95
		46 Leonis min.	,,	14 22 22·06	+ 5·85	− 0·81	10 46 21·07	6·03
Feb. 23, 1st group	h. m. s. 10 34 0·00 s. +9·890	δ Ursæ min. S.P.	W	9 37 2·86	− 9·39	+14·19	18 12 26·83	[−3 24 40·82]
		,,	E	8·44	− 9·37	+ 8·58	,,	
		ε Geminorum	,,	10 1 2·62	− 5·43	+ 0·33	6 36 15·55	−3 24 41·97
		θ Geminorum	,,	10 9 19·99	− 4·06	+ 0·21	6 44 34·21	41·93
		ζ Geminorum	,,	10 21 26·42	− 2·07	+ 0·37	6 56 42·85	41·87
		65 Aurigæ	W	10 38 24·50	+ 0·72	− 0·27	7 13 42·90	42·05
		63 Geminorum	,,	10 45 0·56	+ 1·82	− 0·01	7 20 20·44	41·93
		f Geminorum	,,	10 56 54·78	+ 3·77	+ 0·04	7 32 16·69	41·90
		π Geminorum	,,	11 4 5·37	+ 4·96	− 0·20	7 39 28·28	41·85
		λ Ursæ min. S.P.	,,	11 11 55·15	+ 6·25	+44·03	19 48 2·39	[43·04]
Feb. 23, 2nd group	h. m. s. 14 37 0·00 s. +9·890	Camel. 30 H.	W	13 40 11·43	− 9·36	− 5·21	10 15 54·78	[−3 24 2·08]
		,,	E	8·85	− 9·37	− 2·62	,,	
		42 Leonis min.	,,	14 3 3·84	− 5·59	+ 0·19	10 38 56·64	−3 24 1·80
		46 Leonis min.	,,	14 10 27·19	− 4·38	+ 0·15	10 46 21·10	1·86
		ψ Ursæ maj.	,,	14 26 43·80	− 1·70	+ 0·02	11 2 40·28	1·84
		ξ Ursæ maj.	,,	14 35 34·54	− 0·23	+ 0·18	11 11 32·57	1·92
		58 Ursæ maj.	W	14 47 47·99	+ 1·78	− 0·40	11 23 47·37	2·00
		61 Ursæ maj.	,,	14 58 28·51	+ 3·54	− 0·23	11 34 29·97	1·85
		1 Comæ	,,	15 19 16·60	+ 6·96	− 0·08	11 55 21·72	1·76
		Groom. 1852	,,	15 22 57·12	+ 7·58	− 2·70	11 59 0·35	[1·65]
Feb. 24	h. m. s. 10 24 0·00 s. +9·932	δ Ursæ min. S.P.	W	9 33 4·13	− 8·43	+17·13	18 12 27·17	[−3 20 45·66]
		,,	E	9·83	− 8·41	+11·41	,,	

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, DR. LÖW; CHRONOMETER NIEBERG (*continued*).

Date, 1875	Epoch by chronometer and assumed *hourly* chronometer rate	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Chronometer rate to epoch	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m. s.			h. m. s.	s.	s.	h. m. s.	h. m. s.
Feb. 24 (*cont.*)	10 24 0·00 s. +9·932	ε Geminorum	E	9 57 5·75	− 4·45	+ 0·07	6 36 15·54	−3 20 45·83
		θ Geminorum	„	10 5 23·02	− 3·08	− 0·08	6 44 34·20	45·66
		63 Aurigæ	„	10 23 50·63	− 0·03	− 0·19	7 3 4·81	45·60
		63 Geminorum	W	10 41 3·34	+ 2·82	− 0·26	7 20 20·43	45·47
		f Geminorum	„	10 52 57·84	+ 4·80	− 0·19	7 32 16·68	45·77
Feb. 25	h. m. s. 10 25 0·00 s. +9·948	δ Ursæ min. S.P.	W	9 29 5·94	− 9·27	+16·04	18 12 27·49	} [−3 16 45·22]
		„	E	10·87	− 9·25	+11·09	„	
		ε Geminorum	„	9 53 7·63	− 5·29	− 0·02	6 36 15·53	−3 16 46·79
		θ Geminorum	„	10 1 24·89	− 3·91	− 0·17	6 44 34·18	46·63
		ζ Geminorum	„	10 13 31·46	− 1·91	+ 0·05	6 56 42·83	46·77
		63 Aurigæ	„	10 19 52·64	− 0·85	− 0·27	7 3 4·80	46·72
		65 Aurigæ	W	10 30 29·48	+ 0·91	− 0·61	7 13 42·88	46·90
		63 Geminorum	„	10 37 5·50	+ 2·01	− 0·30	7 20 20·42	46·79
		f Geminorum	„	10 48 59·74	+ 3·98	− 0·24	7 32 16·67	46·81
		π Geminorum	„	10 56 10·55	+ 5·17	− 0·53	7 39 28·26	46·93
		λ Ursæ min. S.P.	„	11 3 55·37	+ 6·45	+50·43	19 48 3·88	[48·37]

Finally, taking the means of the separate groups, we have the following corrections of the chronometers :—

WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, DR. LÖW; CHRONOMETER NIEBERG.

Date	Epoch by chronometer	Chronometer correction to local sidereal time			
	h. m. s.		h. m.	s.	h. m. s.
1875, Jan. 30 . . .	19 43 0·00	Circle E	−4 58	46·138	−4 58 46·22
		„ W		46·295	
„ Jan. 31, 1st group .	9 5 0·00	Circle E	−4 56	33·023	−4 56 33·10
		„ W		33·170	
„ Jan. 31, 2nd group .	11 35 0·00	Circle E	−4 56	8·283	−4 56 8·38
		„ W		8·475	
„ Jan. 31, 3rd group .	17 35 0·00	Circle E	−4 55	8·390	−4 55 8·27
		„ W		8·155	
„ Jan. 31, 4th group .	19 23 0·00	Circle E	−4 54	50·357	−4 54 50·33
		„ W		50·307	
„ Feb. 5	18 56 0·00	Circle E	−4 34	58·365	−4 34 58·37
		„ W		58·380	
„ Feb. 6	7 13 0·00	Circle E	−4 32	55·460	−4 32 55·62
		„ W		55·786	
„ Feb. 7	5 41 0·00	Circle E	−4 29	11·662	−4 29 11·80
		„ W		11·930	
„ Feb. 8	10 11 0·00	Circle E	−4 24	29·227	−4 24 29·22
		„ W		29·207	
„ Feb. 9, 1st group .	5 25 0·00	Circle E	−4 21	17·195	−4 21 17·22
		„ W		17·235	
„ Feb. 9, 2nd group .	12 0 0·00	Circle E	−4 20	11·732	−4 20 11·89
		„ W		12·045	

WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH. OBSERVER, MR. GILL; CHRONOMETER 43.

Date	Epoch by chronometer	Chronometer correction to local sidereal time		
	h. m.	h. m. s.	h. m. s.	
1875, Feb. 9, 1st group .	2 54	Circle E −1 37 23·818 „ W 23·915	−1 37 23·87	
„ Feb. 9, 2nd group .	9 27	Circle E −1 37 23·753 „ W 23·720	−1 37 23·74	

WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, MR. GILL; CHRONOMETER 43.

Date	Epoch by chronometer	Chronometer correction to local sidereal time		
	h. m.	h. m. s.	h. m. s.	
1875, Feb. 11 . . .	10 55	Circle E −1 37 20·778 „ W 20·742	−1 37 20·76	

OBSERVER, DR. LÖW; CHRONOMETER NIEBERG.

Date	Epoch by chronometer	Chronometer correction to local sidereal time		
	h. m. s.	h. m. s.	h. m. s.	
1875, Feb. 18 . . .	5 18 0·00	Circle E −3 45 26·560 „ W 26·865	−3 45 26·71	
„ Feb. 19, 1st group .	10 49 0·00	Circle E −3 40 33·878 „ W 33·803	−3 40 33·84	
„ Feb. 19, 2nd group .	14 57 0·00	Circle E −3 39 52·640 „ W 52·828	−3 39 52·73	
„ Feb. 20, 1st group .	10 45 0·00	Circle E −3 36 36·055 „ W 36·003	−3 36 36·03	
„ Feb. 20, 2nd group .	13 47 0·00	Circle E −3 36 5·868 „ W 5·963	+3 36 5·92	
„ Feb. 23, 1st group .	10 34 0·00	Circle E −3 24 41·923 „ W 41·932	−3 24 41·93	
„ Feb. 23, 2nd group .	14 37 0·00	Circle E −3 24 1·855 „ W 1·870	−3 24 1·86	
„ Feb. 24 . . .	10 24 0·00	Circle E −3 20 45·697 „ W 45·620	−3 20 45·66	
„ Feb. 25 . . .	10 25 0·00	Circle E −3 16 46·728 „ W 46·858	−3 16 46·79	

The preceding time determinations, with their reductions, have all been given, although in several cases they are not absolutely required for any particular purpose. They were reduced, and are inserted to give as good an idea as possible of the probable value of the separate determinations. We shall now for convenience' sake divide them into sets for the various purposes for which they are specially wanted.

On January 30 and 31, 1875, signals were exchanged between Aden and Suez to determine the difference of longitude between the two places.

From the time determinations we have the corrections for chronometer 'Nieberg':—

Date	Epoch by chronometer	Chronometer correction to local sidereal time	Adopted *hourly* chronometer rate
	h. m. s.	h. m. s.	s.
1875, Jan 30 . . .	19 43 0·00	−4 58 46·22	+9·958
„ Jan. 31, 1st group .	9 5 0·00	−4 56 33·10	+9·888
„ Jan. 31, 2nd group	11 35 0·00	−4 56 8·38	
„ Jan. 31, 3rd group	17 35 0·00	−4 55 8·27	+9·962
„ Jan. 31, 4th group	19 23 0·00	−4 54 50·33	

These corrections and rates are to be applied to the chronometer times in the following table:—

Signals sent to and received from Aden.

The following are the chronometer times of despatch and receipt of signals to and from Aden. In anticipation of the observations from which they are derived, the sidereal times have already been given with the corresponding Aden times in the deduction of the difference of longitude :—

1875, January 30													1875, January 31					
No. of signal	Set 1			Set 2			Set 3			Set 4			Set 5			Set 6		
	Time by chronometer Nieberg			Time by chronometer Nieberg			Time by chronometer Nieberg			Time by chronometer Nieberg			Time by chronometer Nieberg			Time by chronometer Nieberg		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m	s.	h.	m.	s.
1	18	25	45·0	18	32	2·0	18	41	52·5	18	45	51·8	10	15	39·1	10	21	51·5
2			55·0			11·9		42	12·8		46	1·9			49·3		22	1·0
3		26	15·3			31·8			22·2			11·9			59·9			11·0
4			25·7			52·0			32·5			22·8		16	9·5			21·0
5			35·0		33	21·8			42·7			51·8			19·5			31·0
6			45·0			31·8		43	11·9		47	1·8			39·1		23	11·2
7			55·1			51·5			22·2			11·9			49·4			21·3
8		27	15·1		34	2·1	18	43	42·1			21·7			59·1			31·2
9			25·3			12·2		...				52·2		17	9·1			51·4
10			34·9			31·8		...			48	2·0			19·1		24	1·0
11			44·9			51·5		...				11·7			39·2			11·1
12			55·0		35	1·7		...				21·8			49·1			31·0
13		28	14·8			11·9		..				31·5			59·0			51·6
14			25·0			21·8		..				52·3		18	9·0		25	1·1
15			44·8			31·7		...			49	2·1			39·0			11·1
16	18	28	54·9			51·8		...				12·1			49·0			21·2
17		...			36	1·5		...				21·8			59·0	10	25	31·1
18		...				11·8		...				31·8		19	8·9		...	
19		...				21·4		...				51·5	10	19	18·8		...	
20		...				31·9		...			50	1·9		...			...	
21		...				52·0		...				11·6		...			...	
22		...			37	1·8		...				21·5		...			...	
23		...				11·9		...		18	50	31·5		...			...	
24		...				21·7		...			...			...			...	
25		...		18	37	31·7		...			...			...			...	

1875, January 31 (*continued*).

No. of signal	Set 7			Set 8			Set 9			Set 10			Set 11			Set 12		
	Time by chronometer Nieberg			Time by chronometer Nieberg			Time by chronometer Nieberg			Time by chronometer Nieberg			Time by chronometer Nieberg			Time by chronometer Nieberg		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	10	28	51·2	10	33	36·5	18	0	33·0	18	7	10·9	18	15	1·8	18	27	58·9
2		29	1·1			46·7			43·0			20·8			20·8		28	18·8
3			11·2			56·2			52·9			31·0			30·9			28·6
4			21·7		34	6·7		1	2·9			51·0			51·1			38·8
5			31·5			16·2			22·3		8	1·0		16	10·9			48·7
6			51·0			36·7			33·0			11·0			20·9			58·8
7		30	1·5			46·0			42·9			21·0			31·1		29	18·8
8			11·8			56·2			52·8			31·0			51·2			28·2
9			21·0		35	6·2		2	2·7			51·3		17	1·0			38·1
10			31·0			16·0			22·7		9	1·8			11·0			47·9
11			51·6			36·0			32·8			10·9			21·0			58·7
12		31	1·5			46·0			42·7			21·0			30·9		30	18·2
13			11·7			56·0			52·4			31·0			51·0			28·1
14			21·8		36	6·0		3	2·6			51·0		18	0·8			38·0
15			31·2			16·1			32·7		10	1·0	18	18	10·9			47·9
16			51·1			36·1			42·6			10·9		...		18	30	58·1
17		32	1·0			46·0			52·1			20·9		...			...	
18			11·0			56·0	18	4	2·3	18	10	31·7		...			...	
19			21·0		37	6·0		...			...			...			...	
20	10	32	31·1	10	37	16·0		...			...			...			...	

On February 9, 1875, a determination of the difference of personal equation was made between Dr. Löw, observing with the transit, and Mr. Gill, with the altazimuth. The details are :—

COMPARISONS OF CHRONOMETERS.

1st Group.

	Nieberg	(43)
	h. m. s.	h. m. s.
Dr. Löw	3 55 8·0	1 11 0·0
Mr. Gill	3 55 10·0	1 11 2·0
Mr. Gill	6 36 41·0	3 52 59·5
Dr. Löw	6 39 42·0	3 56 1·0

2nd Group.

Nieberg	(43)
h. m. s.	h. m. s.
11 18 33·0	8 35 38·0
11 21 36·0	8 38 41·5
11 57 48·0	9 14 59·5
12 0 52·0	9 18 4·0
12 37 6·0	9 54 24·0
12 40 12·0	9 57 30·5

From the time determinations previously given we have :—

For Dr. Löw with the transit instrument and chronometer Nieberg.

Date	Epoch by chronometer	Chronometer correction to local sidereal time	Adopted *hourly* chronometer rate
	h. m. s.	h. m. s.	s.
1875, Feb. 9, 1st group . .	5 25 0·00	−4 21 17·22	+9·924
„ Feb. 9, 2nd group . .	12 0 0·00	−4 20 11·89	

For Mr. Gill with the altazimuth and chronometer 43.

Date	Epoch by chronometer	Chronometer correction to local sidereal time	Adopted *hourly* chronometer rate
	h. m.	h. m. s.	s.
1875, Feb. 9, 1st group . .	2 54	−1 37 23·87	+0·020
„ Feb. 9, 2nd group . .	9 27	−1 37 23·74	

Taking the means of the separate groups of chronometer comparisons, we have :—

1st Group.

Nieberg	(43)
h. m. s.	h. m. s.
5 16 40·25	2 32 45·62

2nd Group.

Nieberg	(43)
h. m. s.	h. m. s.
11 59 21·17	9 16 32·92

and, applying the chronometer corrections, we obtain finally :—

1st Group.

	h. m. s.
Dr. Löw with chronometer Nieberg makes local sidereal time	0 55 21·65
Mr. Gill „ „ 43 „ „ „	0 55 21·75

2nd Group.

	h. m. s.
Dr. Löw with chronometer Nieberg makes local sidereal time	7 39 9·17
Mr. Gill „ „ 43 „ „ „	7 39 9·18

Therefore—

LÖW—GILL.

s.
−0·10
−0·01

As another determination of this personal equation was made at Alexandria on March 3, 1875, the foregoing results have been taken over to Chap. XVI., where the final result will be found.

On February 11, 1875, observations were taken to determine the difference of personal equation in observing signals with the 'Thomson' galvanometer, by Dr. Löw, and Mr. Gill using the same chronometer, and watching the same spot of light. The mean of 243 signals gave :—

$$\text{Löw} - \text{Gill} \ldots = +0^{s}.03 \pm 0^{s}.011$$

On February 19, 20, 23, and 24, 1875, signals were exchanged between Suez and Alexandria to determine the difference of longitude. From the time determinations we obtain the following corrections for chronometer 'Nieberg' to be applied to the signals :—

Date	Epoch by chronometer	Chronometer correction to local sidereal time	Adopted *hourly* chronometer rate
	h. m. s.	h. m. s.	s.
1875, Feb. 19, 1st group . .	10 49 0·00	−3 40 33·84	+9·944
„ Feb. 19, 2nd group . .	14 57 0·00	−3 39 52·73	
„ Feb. 20, 1st group . .	10 45 0·00	−3 36 36·03	+9·926
„ Feb. 20, 2nd group . .	13 47 0·00	−3 36 5·92	
„ Feb. 23, 1st group . .	10 34 0·00	−3 24 41·93	+9·894
„ Feb. 23, 2nd group . .	14 37 0·00	−3 24 1·86	
„ Feb. 24	10 24 0·00	−3 20 45·66	+9·931

The succeeding tables contain the chronometer and local sidereal times of despatch and receipt of signals at Suez ; besides which, in order to deduce the difference of longitude, the Alexandria sidereal times of receipt and despatch of the corresponding signals at that end of the line are here given :—

1875, FEBRUARY 19

SET 1

Number of signal	Time by chronometer Nieberg	Suez sidereal time ; signals *sent*	Corresponding Alexandria sidereal time ; signals *received*	Resulting longitude, Suez east of Alexandria
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	13 0 48·1	9 20 36·11	9 9 57·18	0 10 38·93
2	58·3	46·33	10 7·18	39·15
3	1 28·4	21 16·52	37·28	39·24
4	38·5	26·64	47·38	39·26
5	48·6	36·77	57·38	39·39
6	58·7	46·90	11 7·38	39·52
7	2 8·5	56·73	17·38	39·35
8	38·3	22 26·61	47·58	39·03
9	48·0	36·34	57·58	38·76
10	58·6	46·96	12 7·48	39·48
11	3 8·4	56·79	17·58	39·21
12	28·5	23 16·96	37·68	39·28
13	38·5	26·98	47·58	39·40
14	48·4	36·91	57·58	39·33
15	4 28·1	24 16·72	13 37·69	39·03
16	38·5	27·15	47·79	39·36
17	48·2	36·87	57·79	39·08
18	58·2	46·90	14 7·79	39·11
19	5 8·2	56·93	17·79	39·14
20	38·6	25 27·41	47·89	39·52
21	58·3	47·17	15 8·19	38·98
22	13 6 8·0	9 25 56·89	9 15 18·09	38·80

1875, FEBRUARY 19 (*continued*).

SET 2

Number of signal	Time by chronometer Nieberg	Suez sidereal time; signals *received*	Corresponding Alexandria sidereal time; signals *sent*	Resulting longitude, Suez east of Alexandria
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	13 10 54·8	9 30 44·49	9 20 5·10	0 10 39·39
2	11 14·6	31 4·34	25·20	39·14
3	24·7	14·47	35·30	39·17
4	35·0	24·80	45·70	39·10
5	12 15·0	32 4·91	21 25·70	39·21
6	25·0	14·93	35·70	39·23
7	35·0	24·96	45·80	39·16
8	44·8	34·79	55·50	39·29
9	54·9	44·92	22 5·70	39·22
10	13 25·0	33 15·10	36·00	39·10
11	45·3	35·45	56·10	39·35
12	55·0	45·18	23 5·90	39·28
13	14 24·7	34 14·96	35·60	39·36
14	34·8	25·09	45·90	39·19
15	45·2	35·52	56·61	38·91
16	54·8	45·14	24 5·91	39·23
17	15 14·3	35 4·70	25·61	39·09
18	24·1	14·52	35·31	39·21
19	34·7	25·15	45·71	39·44
20	44·1	34·58	56·01	38·57
21	16 14·2	36 4·76	25 25·51	39·25
22	24·1	14·69	35·61	39·08
23	34·2	24·82	45·71	39·11
24	13 16 54·1	9 36 44·77	9 26 5·61	39·16

SET 3*

Number of signal	Time by chronometer Nieberg	Suez sidereal time; signals *sent*	Corresponding Alexandria sidereal time; signals *received*	Resulting longitude, Suez east of Alexandria
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	13 20 38·4	9 40 29·69	9 29 50·72	0 10 38·97
2	58·4	49·75	30 10·52	39·23
3	21 8·0	59·38	20·72	38·66
4	28·5	41 19·93	40·82	39·11
5	39·0	30·46	51·52	38·94
6	48·4	39·89	31 0·62	39·27
7	58·4	49·91	10·82	39·09
8	22 8·0	59·54	20·52	39·02
9	38·5	42 30·12	50·92	39·20
10	24 8·0	43 59·88	33 21·02	38·86
11	28·5	44 20·44	41·12	39·32
12	48·6	40·59	34 1·22	39·37
13	58·0	50·02	11·12	38·90
14	25 8·2	45 0·24	21·32	38·92
15	28·5	20·60	41·43	39·17
16	13 25 58·4	9 45 50·58	9 35 11·53	39·05

* Some signals in this set, not given above, have been rejected, as they are probably 10^s wrong.

1875, FEBRUARY 19 (*continued*).

SET 4

Number of signal	Time by chronometer Nieberg	Suez sidereal time ; signals *received*	Corresponding Alexandria sidereal time ; signals *sent*	Resulting longitude, Suez east of Alexandria
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	13 27 12·9	9 47 5·29	9 36 25·93	0 10 39·36
2	33·1	25·54	46·23	39·31
3	42·1	34·56	55·63	38·93
4	52·0	44·49	37 5·73	38·76
5	28 22·7	48 15·28	35·93	39·35
6	33·0	25·60	46·13	39·47
7	42·7	35·33	55·83	39·50
8	52·0	44·66	38 5·53	39·13
9	29 12·9	49 5·61	26·23	39·38
10	22·0	14·74	35·53	39·21
11	32·7	25·47	45·93	39·54
12	42·0	34·79	55·73	39·06
13	30 12·0	50 4·88	39 25·53	39·35
14	22·0	14·90	35·53	39·37
15	32·0	24·93	46·13	38·80
16	41·9	34·86	55·74	39·12
17	31 12·0	51 5·05	40 25·64	39·41
18	21·9	14·98	35·74	39·24
19	42·0	35·13	55·84	39·29
20	52·0	45·16	41 5·64	39·52
21	32 11·8	52 5·01	25·74	39·27
22	21·9	15·14	35·84	39·30
23	32·0	25·27	45·94	39·33
24	13 32 51·8	9 52 45·12	9 42 5·84	39·28

1875, FEBRUARY 20

SET 5

Number of signal	Time by chronometer Nieberg	Suez sidereal time ; signals *sent*	Corresponding Alexandria sidereal time ; signals *received*	Resulting longitude, Suez east of Alexandria
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	12 26 13·0	8 49 53·72	8 39 14·53	0 10 39·19
2	23·1	50 3·85	24·83	39·02
3	43·9	24·70	45·33	39·37
4	27 13·0	53·88	40 14·93	38·95
5	23·3	51 4·21	25·33	38·88
6	33·5	14·44	35·43	39·01
7	43·9	24·87	45·74	39·13
8	28 3·2	44·22	41 5·14	39·08
9	13·1	54·15	15·14	39·01
10	23·3	52 4·38	25·34	39·04
11	33·7	14·80	35·44	39·36
12	43·5	24·63	45·44	39·19
13	29 3·2	44·39	42 5·44	38·95
14	13·1	54·31	15·54	38·77
15	23·7	53 4·94	25·64	39·30
16	34·0	15·27	36·24	39·03
17	30 3·0	44·35	43 5·44	38·91
18	13·0	54·38	15·24	39·14
19	23·3	54 4·71	25·64	39·07
20	31 3·0	44·51	44 5·64	38·87
21	13·0	54·54	15·54	39·00
22	12 31 33·9	8 55 15·50	8 44 36·24	39·26

1875, FEBRUARY 20 (*continued*).

SET 6

Number of signal	Time by chronometer Nieberg	Suez sidereal time ; signals *received*	Corresponding Alexandria sidereal time ; signals *sent*	Resulting longitude, Suez east of Alexandria
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	12 33 12·0	8 56 53·87	8 46 14·44	0 10 39·43
2	22·0	57 3·89	24·44	39·45
3	32·1	14·02	34·64	39·38
4	42·1	24·06	44·84	39·22
5	34 11·1	53·14	47 14·44	38·70
6	22·0	58 4·07	24·74	39·33
7	32·0	14·10	34·94	39·16
8	42·0	24·12	44·84	39·28
9	52·0	34·15	54·74	39·41
10	35 12·3	54·51	48 15·44	39·07
11	32·2	59 14·46	35·54	38·92
12	42·3	24·59	45·64	38·95
13	52·1	34·42	55·64	38·78
14	36 12·1	54·47	49 15·24	39·23
15	22·0	9 0 4·40	25·44	38·96
16	32·2	14·63	35·54	39·09
17	42·1	24·55	45·54	39·01
18	52·2	34·68	55·44	39·24
19	37 12·1	54·63	50 15·64	38·99
20	22·0	1 4·56	25·44	39·12
21	32·8	15·39	36·14	39·25
22	41·9	24·52	45·44	39·08
23	52·0	34·64	55·44	39·20
24	38 12·1	54·80	51 15·54	39·26
25	32·1	2 14·85	36·24	38·61
26	12 38 42·0	9 2 24·78	8 51 45·44	39·34

SET 7

Number of signal	Time by chronometer Nieberg	Suez sidereal time ; signals *sent*	Corresponding Alexandria sidereal time ; signals *received*	Resulting longitude, Suez east of Alexandria
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	12 44 23·4	9 8 7·13	8 57 28·06	0 10 39·07
2	33·5	17·25	38·06	39·19
3	43·2	26·98	48·06	38·92
4	45 3·2	47·03	58 8·16	38·87
5	13·0	56·86	17·96	38·90
6	23·0	9 6·89	28·07	38·82
7	33·7	17·62	38·27	39·35
8	43·9	27·85	48·47	39·38
9	46 13·5	57·53	59 18·47	39·06
10	23·7	10 7·75	28·67	39·08
11	33·8	17·88	38·67	39·21
12	43·3	27·41	48·47	38·94
13	47 3·5	47·66	9 0 8·47	39·19
14	13·7	57·89	18·67	39·22
15	23·8	11 8·02	28·77	39·25
16	33·1	17·35	38·47	38·88
17	43·5	27·77	48·67	39·10
18	48 3·6	47·93	1 8·67	39·26
19	13·0	57·35	18·57	38·78
20	23·3	12 7·68	28·57	39·11
21	33·8	18·21	38·87	39·34
22	43·3	27·74	48·57	39·17
23	49 3·5	47·99	2 8·87	39·12
24	13·0	57·52	18·47	39·05
25	12 49 33·8	9 13 18·38	9 2 39·17	39·21

1875, FEBRUARY 20 (*continued*).

SET 8

Number of signal	Time by chronometer Nieberg	Suez sidereal time; signals *received*	Corresponding Alexandria sidereal time; signals *sent*	Resulting longitude, Suez east of Alexandria
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	12 51 12·1	9 14 56·95	9 4 17·88	0 10 39·07
2	22·1	15 6·98	27·68	39·30
3	52·0	36·96	57·48	39·48
4	52 12·0	57·02	5 17·98	39·04
5	42·0	16 27·10	47·98	39·12
6	52·0	37·13	57·98	39·15
7	53 22·0	17 7·21	6 27·98	39·23
8	32·1	17·34	38·38	38·96
9	42·0	27·27	48·08	39·19
10	52·1	37·39	58·48	38·91
11	54 12·1	57·45	7 18·48	38·97
12	22·0	18 7·38	28·68	38·70
13	32·1	17·50	38·58	38·92
14	42·1	27·53	48·48	39·05
15	52·1	37·56	58·48	39·08
16	55 22·1	19 7·64	8 28·68	38·96
17	32·3	17·87	38·88	38·99
18	42·1	27·69	48·48	39·21
19	52·0	37·62	58·48	39·14
20	56 12·1	57·78	9 18·68	39·10
21	22·0	20 7·70	28·88	38·82
22	32·0	17·73	38·68	39·05
23	42·1	27·86	48·78	39·08
24	12 56 52·0	9 20 37·79	9 9 58·68	39·11

1875, FEBRUARY 23

SET 9

Number of signal	Time by chronometer Nieberg	Suez sidereal time; signals *received*	Corresponding Alexandria sidereal time; signals *sent*	Resulting longitude, Suez east of Alexandria
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	12 35 10·5	9 10 48·55	9 0 9·61	0 10 38·94
2	20·1	58·18	19·71	38·47
3	30·0	11 8·11	29·61	38·50
4	40·0	18·14	39·61	38·53
5	36 0·2	38·40	59·81	38·59
6	10·3	48·52	1 9·91	38·61
7	20·2	58·45	20·01	38·44
8	29·9	12 8·18	29·81	38·37
9	40·0	18·31	39·71	38·60
10	37 0·2	38·56	2 0·41	38·15
11	10·0	48·39	10·01	38·38
12	20·0	58·41	20·11	38·30
13	29·9	13 8·34	29·81	38·53
14	39·9	18·37	39·61	38·76
15	38 0·3	38·82	3 0·31	38·51
16	10·0	48·55	10·11	38·44
17	20·1	58·68	20·11	38·57
18	30·0	14 8·61	30·31	38·30
19	40·1	18·73	40·01	38·72
20	59·9	38·59	4 0·01	38·58
21	39 10·0	48·72	10·21	38·51
22	20·1	58·84	20·41	38·43
23	12 39 30·2	9 15 8·97	9 4 30·61	38·36

1875, FEBRUARY 23 (*continued*).

SET 10

Number of signal	Time by chronometer Nieberg	Suez sidereal time; signals *sent*	Corresponding Alexandria sidereal time; signals *received*	Resulting longitude, Suez east of Alexandria
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	12 44 9·0	9 19 48·53	9 9 10·02	0 10 38·51
2	19·1	58·66	20·12	38·54
3	29·7	20 9·29	30·72	38·57
4	49·8	29·44	50·62	38·82
5	45 9·1	48·80	10 10·32	38·48
6	19·6	59·33	20·82	38·51
7	29·9	21 9·65	31·02	38·63
8	39·9	19·68	41·02	38·66
9	50·0	29·81	51·12	38·69
10	46 19·1	58·99	11 20·72	38·27
11	29·1	22 9·02	30·92	38·10
12	39·7	19·64	41·02	38·62
13	49·0	28·97	50·62	38·35
14	47 9·0	49·03	12 10·72	38·31
15	19·0	59·05	20·62	38·43
16	29·5	23 9·58	31·12	38·46
17	39·8	19·91	41·12	38·79
18	48 8·9	49·09	13 10·42	38·67
19	39·8	24 20·07	41·12	38·95
20	49·2	29·50	51·03	38·47
21	49 9·1	49·45	14 11·03	38·42
22	19·0	59·38	20·83	38·55
23	40·0	25 20·44	41·73	38·71
24	49·8	30·27	51·33	38·94
25	50 9·1	49·62	15 11·03	38·59
26	19·0	59·55	21·23	38·32
27	29·8	26 10·37	31·73	38·64
28	49·0	29·63	51·23	38·40
29	51 9·0	49·68	16 11·03	38·65
30	19·4	27 0·11	21·43	38·68
31	39·7	20·48	41·73	38·75
32	49·2	30·00	51·83	38·17
33	52 8·9	49·76	17 11·23	38·53
34	39·9	28 20·84	42·13	38·71
35	53 9·0	50·02	18 11·73	38·29
36	19·0	29 0·05	21·73	38·32
37	39·5	20·60	42·03	38·57
38	49·3	30·43	51·83	38·60
39	54 9·0	50·19	19 11·73	38·46
40	19·0	30 0·21	21·83	38·38
41	30·1	11·34	32·63	38·71
42	49·1	30·39	52·13	38·26
43	55 8·9	50·25	20 12·03	38·22
44	19·2	31 0·58	22·13	38·45
45	29·1	10·50	32·23	38·27
46	12 55 39·9	9 31 21·33	9 20 42·93	38·40

1875, FEBRUARY 23 (*continued*).

SET 11

Number of signal	Time by chronometer Nieberg	Suez sidereal time; signals *received*	Corresponding Alexandria sidereal time; signals *sent*	Resulting longitude, Suez east of Alexandria
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	12 58 20·1	9 34 1·97	9 23 23·64	0 10 38·33
2	30·2	12·10	33·64	38·46
3	39·7	21·63	43·04	38·59
4	59 0·4	42·38	24 3·84	38·54
5	9·9	51·91	13·64	38·27
6	19·9	35 1·94	23·64	38·30
7	30·1	12·16	33·74	38·42
8	39·9	21·99	43·74	38·25
9	13 0 0·3	42·45	25 4·04	38·41
10	10·0	52·17	13·94	38·23
11	20·2	36 2·40	24·04	38·36
12	39·9	22·16	44·04	38·12
13	1 20·1	37 2·47	26 24·04	38·43
14	29·9	12·29	34·24	38·05
15	39·9	22·32	43·84	38·48
16	59·8	42·27	27 4·14	38·13
17	2 20·2	38 2·73	24·04	38·69
18	30·3	12·86	34·24	38·62
19	39·9	22·48	43·94	38·54
20	3 9·1	51·77	28 13·74	38·03
21	20·1	39 2·79	24·44	38·35
22	4 0·1	42·90	29 4·44	38·46
23	10·4	53·23	14·74	38·49
24	20·1	40 2·96	24·34	38·62
25	30·0	12·89	34·34	38·55
26	40·0	22·91	44·14	38·77
27	5 0·1	43·07	30 4·44	38·63
28	10·3	53·30	14·74	38·56
29	30·0	41 13·05	34·84	38·21
30	40·1	23·18	44·74	38·44
31	6 0·3	43·43	31 4·74	38·69
32	10·2	53·36	14·84	38·52
33	20·3	42 3·49	24·94	38·55
34	40·1	23·34	44·94	38·40
35	7 0·1	43·40	32 5·14	38·26
36	9·9	53·22	14·74	38·48
37	30·1	43 13·48	35·05	38·43
38	13 7 40·1	9 43 23·51	9 32 44·85	38·66

SET 12

Number of signal	Time by chronometer Nieberg	Suez sidereal time; signals *sent*	Corresponding Alexandria sidereal time; signals *received*	Resulting longitude, Suez east of Alexandria
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	13 10 9·4	9 45 53·23	9 35 14·85	0 10 38·38
2	19·3	46 3·15	24·75	38·40
3	29·9	13·78	35·15	38·63
4	49·9	33·83	55·05	38·78
5	11 9·6	53·59	36 14·95	38·64
6	19·2	47 3·22	24·95	38·27
7	39·1	23·17	45·15	38·02
8	50·0	34·10	55·25	38·85
9	12 9·7	53·83	37 15·15	38·68
10	40·0	48 24·24	45·35	38·89

1875, FEBRUARY 23 (*continued*)

SET 12 (*continued*)

Number of signal	Time by chronometer Nieberg	Suez sidereal time ; signals *sent*	Corresponding Alexandria sidereal time ; signals *received*	Resulting longitude ; Suez east of Alexandria
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
11	13 12 50·0	9 48 34·26	9 37 55·35	0 10 38·91
12	13 9·3	53·62	38 15·15	38·47
13	19·0	49 3·34	25·05	38·29
14	29·9	14·27	35·85	38·42
15	40·2	24·60	45·95	38·65
16	50·0	34·43	55·85	38·58
17	14 9·0	53·48	39 15·15	38·33
18	40·0	50 24·56	45·95	38·61
19	50·0	34·59	56·05	38·54
20	15 9·1	53·75	40 15·45	38·30
21	19·1	51 3·77	26·05	37·72
22	29·9	14·60	35·95	38·65
23	40·1	24·83	46·15	38·68
24	13 15 49·2	33·96	9 40 55·85	38·11

1875, FEBRUARY 24

SET 13

Number of signal	Time by chronometer Nieberg	Suez sidereal time ; signals *received*	Corresponding Alexandria sidereal time ; signals *sent*	Resulting longitude ; Suez east of Alexandria
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	12 45 57·0	9 25 34·84	9 14 55·88	0 10 38·96
2	46 17·1	55·00	15 16·38	38·62
3	27·2	26 5·13	26·28	38·85
4	37·0	14·95	36·28	38·67
5	57·0	35·01	56·38	38·63
6	47 27·0	27 5·09	16 26·28	38·81
7	36·2	14·32	36·08	38·24
8	48 7·0	45·20	17 6·38	38·82
9	17·0	55·23	16·48	38·75
10	27·2	28 5·45	26·88	38·57
11	36·9	15·18	36·48	38·70
12	57·1	35·44	56·88	38·56
13	49 7·2	45·56	18 7·08	38·48
14	17·0	55·39	16·88	38·51
15	27·0	29 5·42	26·68	38·74
16	37·1	15·55	36·88	38·67
17	50 7·0	45·53	19 7·08	38·45
18	27·0	30 5·58	26·88	38·70
19	36·8	15·41	36·58	38·83
20	56·9	35·56	58·09	[37·47*]
21	51 16·9	55·62	20 17·19	38·43
22	26·9	31 5·65	27·09	38·56
23	37·0	15·77	37·29	38·48
24	57·0	35·83	57·09	38·74
25	52 17·1	55·99	21 17·29	38·70
26	27·1	32 6·02	27·39	38·63
27	56·7	35·70	57·09	38·61
28	53 27·1	33 6·19	22 27·39	38·80
29	56·7	35·87	57·29	38·58
30	54 6·8	45·99	23 7·49	38·50
31	16·9	56·12	17·29	38·83
32	12 54 36·5	9 34 15·78	9 23 37·29	38·49

[*] Discordant ; rejected.

1875, FEBRUARY 24 (*continued*)

SET 14

Number of signal	Time by chronometer Nieberg	Suez sidereal time ; signals *sent*	Corresponding Alexandria sidereal time ; signals *received*	Resulting longitude ; Suez east of Alexandria
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	12 56 52·9	9 36 32·55	9 25 54·29	0 10 38·26
2	57 3·9	43·58	26 4·69	38·89
3	13·9	53·61	14·59	39·02
4	24·1	37 3·83	24·89	38·94
5	53·8	33·62	55·25	38·37
6	58 3·9	43·74	27 4·70	39·04
7	14·0	53·87	15·00	38·87
8	43·0	38 22·95	44·90	38·05
9	53·5	33·48	55·10	38·38
10	59 4·1	44·11	28 5·30	38·81
11	14·1	54·13	15·50	38·63
12	24·0	39 4·06	25·20	38·86
13	43·4	23·52	45·00	38·52
14	13 0 ·3	43·47	29 4·90	38·57
15	14·0	54·20	15·60	38·60
16	23·3	40 3·54	25·30	38·24
17	43·2	23·49	45·20	38·29
18	53·0	33·32	54·90	38·42
19	1 3·9	44·25	30 5·40	38·85
20	14·0	54·37	15·50	38·87
21	23·8	41 4·20	25·50	38·70
22	53·3	33·78	55·30	38·48
23	2 3·4	43·91	31 5·40	38·51
24	14·0	54·54	15·60	38·94
25	23·5	42 4·06	25·60	38·46
26	43·5	24·12	45·40	38·72
27	53·1	33·75	55·20	38·55
28	3 3·2	43·87	32 5·50	38·37
29	13·4	54·10	15·50	38·60
30	24·9	43 5·63	27·30	38·33
31	53·2	34·01	55·70	38·31
32	4 23·3	44 4·19	33 25·71	38·48
33	53·2	34·18	55·41	38·77
34	5 3·0	44·00	34 5·51	38·49
35	13·1	54·13	15·61	38·52
36	23·1	45 4·16	25·91	38·25
37	43·0	24·11	45·41	38·70
38	6 3·2	44·37	35 6·01	38·36
39	13·1	54·29	16·21	38·08
40	23·2	46 4·42	25·91	38·51
41	53·2	34·50	55·71	38·79
42	7 3·1	44·43	36 6·11	38·32
43	13·2	54·56	16·31	38·25
44	13 7 23·1	9 47 4·49	9 36 26·31	38·18

1875, FEBRUARY 24 (*continued*)

SET 15

Number of signal	Time by chronometer Nieberg	Suez sidereal time; signals *received*	Corresponding Alexandria sidereal time; signals *sent*	Resulting longitude; Suez east of Alexandria
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	13 9 7·0	9 48 48·68	9 38 10·01	0 10 38·67
2	16·9	58·60	19·61	38·99
3	27·2	49 8·93	30·11	38·82
4	10 7·0	48·84	39 10·31	38·53
5	17·0	58·87	20·31	38·56
6	27·0	50 8·90	30·11	38·79
7	36·9	18·82	40·01	38·81
8	57·1	39·08	59·91	39·17
9	11 7·0	49·01	40 10·22	38·79
10	17·1	59·13	20·22	38·91
11	27·0	51 9·06	30·12	38·94
12	36·9	18·99	40·32	38·67
13	57·0	39·14	41 0·42	38·72
14	12 16·9	59·10	20·42	38·68
15	36·3	52 18·55	40·22	38·33
16	56·7	39·01	42 0·22	38·79
17	13 16·9	59·26	20·42	38·84
18	27·0	53 9·39	30·52	38·87
19	37·0	19·42	40·42	39·00
20	14 7·0	49·50	43 10·62	38·88
21	16·9	59·43	20·52	38·91
22	36·8*	54 19·38	40·32	[39·06†]
23	15 26·8	55 9·52	44 30·72	38·80
24	36·9	19·65	41·32	38·33
25	57·0	39·80	45 0·92	38·88
26	16 6·7	49·53	10·72	38·81
27	17·0	59·85	20·92	38·93
28	27·0	56 9·89	31·12	38·77
29	37·1	20·02	41·32	38·70
30	56·9	39·87	46 1·32	38·55
31	17 7·0	50·00	11·22	38·78
32	16·9	59·93	21·42	38·51
33	27·2	57 10·26	31·52	38·74
34	36·9	19·98	41·22	38·76
35	56·7	39·84	47 1·33	38·51
36	18 7·0	50·17	11·33	38·84
37	26·3	58 9·52	31·03	38·49
38	56·9	40·20	48 1·73	38·47
39	19 17·1	59 0·46	21·53	38·93
40	27·0	10·38	31·53	38·85
41	13 19 37·0	9 59 20·41	9 48 41·43	38·98

* This signal marked $\frac{1}{2}^{s}$ uncertain; rejected. [†] Discordant; rejected.

1875, FEBRUARY 24 (*continued*)

SET 16

Number of signal	Time by chronometer Nieberg	Suez sidereal time; signals *sent*	Corresponding Alexandria sidereal time; signals *received*	Resulting longitude; Suez east of Alexandria
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	13 20 53·3	10 0 36·92	9 49 58·23	0 10 38·69
2	21 53·0	1 36·79	9 50 58·43	38·36
3	22 3·9	47·72	51 8·73	38·99
4	13·5	57·34	18·63	38·71
5	23·2	2 7·07	28·63	38·44
6	43·1	27·02	48·43	38·59
7	53·0	36·95	58·73	38·22
8	23 3·9	47·88	52 9·13	38·75
9	14·0	58·01	19·33	38·68
10	24·0	3 8·03	29·33	38·70
11	43·1	27·19	48·53	38·66
12	24 4·1	48·24	53 9·43	38·81
13	13·9	58·07	19·33	38·74
14	24·0	4 8·20	29·43	38·77
15	43·4	27·66	48·74	38·92
16	53·5	37·79	59·24	38·55
17	25 3·2	47·52	54 9·14	38·38
18	14·0	58·35	19·54	38·81
19	24·0	5 8·37	29·44	38·93
20	43·1	27·53	49·34	38·19
21	26 4·1	48·58	55 10·04	38·54
22	23·9	6 8·44	29·54	38·90
23	43·1	27·69	49·34	38·35
24	27 14·0	58·68	56 19·94	38·74
25	24·0	7 8·70	29·94	38·76
26	54·0	38·78	59·94	38·84
27	28 4·0	48·81	57 10·14	38·67
28	13·9	58·74	20·04	38·70
29	23·8	8 8·67	30·14	38·53
30	43·1	28·02	49·74	38·28
31	53·3	38·25	59·64	38·61
32	29 3·5	48·48	58 10·04	38·44
33	14·0	59·00	20·34	38·66
34	43·5	9 28·58	50·04	38·54
35	53·5	38·61	59 0·14	38·47
36	30 3·5	48·64	10·34	38·30
37	14·1	59·27	20·64	38·63
38	24·2	10 9·39	30·74	38·65
39	43·3	28·55	50·14	38·41
40	55·5*	40·78	10 0 0·04	[40·74]
41	31 4·0	49·30	10·54	38·76
42	13 31 14·0	10 10 59·33	10 0 20·35	38·98

* This signal marked uncertain; rejected.

Taking the means of the results of the foregoing sets, we obtain :—

Difference of Longitude by Signals sent from Suez and recorded at Alexandria.

Date	Set	No. of signals	Resulting longitude, Suez east of Alexandria					
			h.	m.	s.	h.	m.	s.
1875, Feb. 19	1	22	0	10	39·198	0	10	39·133
„ „	3	16			39·068			
„ Feb. 20	5	22	0	10	39·070	0	10	39·084
„ „	7	25			39·099			
„ Feb. 23	10	46	0	10	38·518	0	10	38·505
„ „	12	24			38·492			
„ Feb. 24	14	44	0	10	38·549	0	10	38·588
„ „	16	41			38·626			

Difference of Longitude by Signals sent from Alexandria and recorded at Suez.

Date	Set	No. of signals	Resulting longitude, Suez east of Alexandria					
			h.	m.	s.	h.	m.	s.
1875, Feb. 19	2	24	0	10	39·177	0	10	39·220
„ „	4	24			39·262			
„ Feb. 20	6	26	0	10	39·133	0	10	39·100
„ „	8	24			39·068			
„ Feb. 23	9	23	0	10	38·504	0	10	38·466
„ „	11	38			38·429			
„ Feb. 24	13	31	0	10	38·642	0	10	38·700
„ „	15	40			38·758			

Combining these results, on the supposition that the current time is the same in both directions, we have :—

	h.	m.	s.		s.
Feb. 19, Suez east of Alexandria	0	10	39·176	Current time	+0·044
Feb. 20 „ „			39·092	„	+0·008
Feb. 23 „ „			38·486	„	−0·020
Feb. 24 „ „			38·644	„	+0·056

There being no time determination at Alexandria on February 24, and only one group of observations at Suez on this night, half weight is given to the longitude result of this day. We thus find :—

	h.	m.	s.
Suez east of Alexandria	0	10	38·88
Correction for personal equation between Dr. Löw and Mr. Gill in observing transits *			+0·06

As the personal equation in recording signals with the relay between Dr. Löw and Mr. Gill was not determined, we finally obtain, subject, of course, to any difference from this cause :—

	h.	m.	s.
Suez east of Alexandria	0	10	38·94

and

	s.
Current time	0·022

* See p. 249 and Chapter XVI.

CHAPTER XV.

CONNECTION OF THE BRITISH TRANSIT OF VENUS STATION AND LORD LINDSAY'S LONGITUDE STATION AT SUEZ.

The difference of longitude between the station occupied by Mr. Hunter for the British Government for the observation of the Transit of Venus at Suez and that used by Mr. Gill in Lord Lindsay's longitude operations, was determined by Mr. Gill on February 11, 1875, with a view to comparing the independent results for the longitude of Suez arrived at by different observers and methods.

To this end the Troughton and Simms' altazimuth was mounted on its tripod stand at the Government station, and, as Dr. Löw was unfortunately unwell and unable to observe, Mr. Gill used Dr. Löw's transit instrument, which was at Lord Lindsay's station.[1]

A box of nine chronometers was first conveyed to the Government station, observations for time with the altazimuth were made, and the chronometers inter-compared before and after observing.

The chronometers were then removed to Lord Lindsay's station, where observations for time were taken with Dr. Löw's transit instrument, the chronometers being again compared before and after observing.

The chronometers were taken back to Hunter's station, and observations for time having been again secured, the chronometers were compared as before.

These operations required $7\frac{1}{2}$ hours of continuous observing, involving considerable fatigue, so that Mr. Gill was unable to return again to Lord Lindsay's station and observe there a second time, as originally intended.

Time Determinations at the Government Station.

The following observations of time stars in the vertical of the Pole star were taken with the Troughton and Simms' altazimuth :—

[1] The difference of personal equation in observing with the altazimuth and Dr. Löw's transit instrument by Mr. Gill was afterwards determined ; full details of this will be found in Chapter XIX.

OBSERVER, MR. GILL; CHRONOMETER 43.

Date, 1875	Pole star	Position of circle	Chronometer time of Pole star on wire III.	Level readings	Time star	Chronometer times of transit over wires					Level readings
						I.	II.	III.	IV.	V.	
			h. m. s.	E p. W p.		s.	s.	h. m. s.	s.	s.	E p. W p.
Feb. 11, 1st group	*a* Ursæ min.	W	7 15 2·0	14·2 24·0 22·7 15·3	*η* Geminorum	24·1	38·5	7 43* 53·0	6·9	22·0	12·4 26·5 21·5 17·2
	a Ursæ min.	E	7 51 51·0	16·0 23·0 24·8 14·0	*γ* Geminorum	50·4	36·4	8 6 22·5	9·0	55·0	14·0 25·0 23·0 15·8
	a Ursæ min.	W	8 14 8·0	13·4 25·0 23·2 15·6	*θ* Geminorum	54·9	11·3	8 22 27·1	43·2	59·0	12·2 27·0 23·0 16·1
	„ „	„	„	„ „	*ζ* Geminorum	30·9	45·4	8 32 59·8†	13·6	28·1	12·8 26·5 21·8 17·1
	a Ursæ min.	E	8 40 29·0	16·0 23·0 26·3 13·0	*λ* Geminorum	15·1	1·0	8 46 47·1	33·3	19·4	15·6 23·7 25·1 13·9
	„ „	„	„	„ „	*δ* Geminorum	35·8	21·0	8 49‡ 6·8	52·7	38·0	„ „
	a Ursæ min.	W	9 1 11·0	16·1 22·8 26·5 12·8	[*a*§ Geminorum	45·5	1·5	9 4 17·3	32·8	48·5	26·5 12·6 16·4 23·0]
	„ „	„	„	„ „	*β* Geminorum	19·9	36·0	9 14‖ 50·5	...	20·4	26·5 12·5 16·2 23·2
Feb. 11, 2nd group	*a* Ursæ min.	W	12 56 8·0	25·1 15·0 14·5 25·2	*λ* Draconis	34·8	14·4	13 6 53·1	32·0	10·5	14·5 25·5 25·0 15·2
	„ „	„	„	„ „	*χ* Ursæ maj.	32·8	53·3	13 18 13·4	33·0	53·1	13·6 26·6 23·6 16·2
	„ „	„	„	„ „	*ο* Virginis	42·3	56·0	13 35 9·4	22·9	36·3	„ „
	a Ursæ min.	E	13 42 51·0	14·9 25·2 25·0 15·2	*δ* Ursæ maj.	59·6	34·4	13 48 9·4	44·6	19·5	14·8 25·5 24·8 15·5
	„ „	„	„	„ „	20 Comæ	59·8	45·3	14 0 30·8	17·0	2·4	15·0 25·8 24·5 16·0
	„ „	„	„	„ „	8 Canum ven.	16·0	57·6	14 5 39·8	22·0	4·2	„ „

* Minute supplied.
§ Star double; not being separated, this observation has not been used.
† $9^{s}\cdot8$ in original.
‡ 59^{m} in original.
‖ 15^{m} in original.

From the foregoing observations, assuming the rate of the chronometer $+0^{s}\cdot088$ per hour, we obtain :—

		h.	m.	s.
1st group	Epoch by chronometer	8	31	c −0·190
2nd group	„ „	13	39	c −0·146

Date, 1875	Star	Position of circle	C	Concluded chronometer time of transit over wire III.	R.A. of star, including daily aberration	Rate of chronometer to epoch	t−m	Cc	Chronometer correction
				h. m. s.	h. m. s.	s.	m. s.	s.	h. m. s.
Feb. 11, 1st group	*η* Geminorum	W	−1·243	7 43 53·06	6 7 20·98	+0·07	−0 48·69	+0·24	−1 37 20·46
	γ Geminorum	E	+1·323	8 6 22·52	6 30 30·52	+0·04	−1 28·43	−0·25	20·64
	θ Geminorum	W	−1·107	8 22 27·26	6 44 34·33	+0·01	+0 31·99	+0·21	20·72
	ζ Geminorum	„	−1·267	8 32 59·70	6 56 42·96	0·00	−1 3·95	+0·24	20·45
	λ Geminorum	E	+1·320	8 46 47·04	7 10 55·84	−0·02	−1 29·09	−0·25	20·56
	δ Geminorum	„	+1·249	8 49 6·72	7 12 40·78	−0·03	−0 54·35	−0·24	20·56
	β Geminorum	W	−1·174	9 14 50·60	7 37 41·45	−0·06	−0 11·77	+0·22	20·76
Feb. 11, 2nd group	*λ* Draconis	W	−0·744	13 6 53·35	11 24 2·62	+0·05	+5 30·69	+0·11	−1 37 19·88
	χ Ursæ maj.	„	−0·951	13 18 13·32	11 39 29·00	+0·03	+1 23·86	+0·14	20·29
	ο Virginis	„	−1·432	13 35 9·51	11 58 51·70	+0·01	−1 2·68	+0·21	20·27
	δ Ursæ maj.	E	+0·859	13 48 9·25	12 9 16·80	−0·01	+1 32·32	−0·13	20·27
	20 Comæ	„	+1·259	14 0 30·92	12 23 27·76	−0·03	−0 16·71	−0·18	20·08
	8 Canum ven.	„	+1·018	14 5 39·74	12 27 49·98	−0·04	+0 29·71	−0·15	20·24

Time Determinations at the Government Station.

These give the corrections for (43) to sidereal time at the Government station :—

		h.	m.			h.	m.	s.	h. m. s.
1875, Feb. 11, 1st group, at	8	31	by chronometer, circle E		−1	37	20·587	−1 37 20·59
			„ W				20·598	
„ „ 2nd group, at	13	39	by chronometer, circle E		−1	37	20·197	−1 37 20·17
			„ W				20·147	

and rate of (43) +0·082 per hour

For convenience' sake the chronometer comparisons at *both* stations are given here. The details of the time determinations at Lord Lindsay's station will be found on p. 233 *et seq.*

Chronometer comparisons at the Government station before and after the first group of observations :—

By Coincident Beats.

Before observing.

(43)			(36)		
h.	m.	s.	h.	m.	s.
6	59	5·5	5	56	47·0
7	8	10·0	6	5	50·0

After observing.

(43)			(36)		
h.	m.	s.	h.	m.	s.
9	20	26·0	8	17	44·5
9	26	32·0	8	23	49·5

By Estimation.

Before observing.

h.	m.	s.		s.
(36) 6	0	0·0	(30)	54·0
				54·0
			(32)	27·0
				27·1
			(33)	34·4
				34·5
			(34)	9·8
				9·8
			(35)	21·25
				21·3
			(37)	38·0
				38·1
			(42)	57·6
				57·6

After observing.

h.	m.	s.		s.
(36) 8	19	0·0	(30)	54·9
				54·9
			(32)	27·1
				27·1
			(33)	34·9
				35·0
			(34)	9·5
				9·5
			(35)	21·1
				21·1
			(37)	38·1
				38·1
			(42)	57·5
				57·6

At Lord Lindsay's station the comparisons were :—

By Coincident Beats.

Before observing.

(43)			(36)		
h.	m.	s.	h.	m.	s.
9	57	19·0	8	54	31·5
10	6	32·0	9	3	43·0

After observing.

(43)			(36)		
h.	m.	s.	h.	m.	s.
12	4	5·0	11	0	57·0

By Estimation.

Before observing.

h.	m.	s.		s.
(36) 9	0	0·0	(30)	55·1
				55·2
			(32)	27·1
				27·2
			(33)	35·0
				35·1
			(34)	9·5
				9·5
			(35)	21·1
				21·2
			(37)	38·1
				38·1
			(42)	57·6
				57·6

After observing.

h.	m.	s.		s.
(36) 11	5	0·0	(30)	56·0
				56·1
			(32)	27·5
				27·6
			(33)	35·3
				35·2
			(34)	9·1
				9·1
			(35)	21·1
				21·1
			(37)	38·4
				38·4
			(42)	57·6
				57·6

At the Government station before and after the second group of observations :—

BY COINCIDENT BEATS.

Before observing.

(43)			(36)		
h.	m.	s.	h.	m.	s.
12	37	53·5	11	34	40·0
12	47	10·0	11	43	55·0
12	50	15·5	11	47	0·0

After observing.

(43)			(36)		
h.	m.	s.	h.	m.	s.
14	10	13·5	13	6	45·0
14	13	18·0	13	9	49·0
14	19	30·0	13	16	0·0

BY ESTIMATION.

Before observing.

(36)	h.	m.	s.		s.
	11	39	0	(30)	56·2
					56·4
				(32)	27·5
					27·6 *
				(33)	35·4
					35·3
				(34)	9·05
					9·1
				(35)	21·1
					21·1
				(37)	38·5
					38·5
				(42)	57·5
					57·5

After observing.

(36)	h.	m.	s.		s.
	13	14	0·0	(30)	56·9
					57·0
				(32)	27·8
					27·8
				(33)	35·5
					35·5
				(34)	9·0
					9·0
				(35)	21·1
					21·1
				(37)	38·5
					38·6
				(41)	57·6
					57·6

* 37s·6 in original.

Taking the means of the comparisons before and after observations we have :—

BY COINCIDENT BEATS

At the Government station ; 1st series		At Lord Lindsay's station		At the Government station ; 2nd series	
(43)	(36)	(43)	(36)	(43)	(36)
h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
8 13 33·38	7 11 2·75	11 3 0·25	10 0 2·125	13 29 43·42	12 26 21·50

BY ESTIMATED BEATS

Compared chronometer	(36)	Seconds of compared chronometer	(36)	Seconds of compared chronometer	(36)	Seconds of compared chronometer
	h. m. s.	s.	h. m. s.	s.	h. m. s.	s.
(30)	7 9 0·0	54·45	10 2 0·0	55·60	12 26 0·0	56·62
(32)	...	27·08	...	27·35	...	27·68
(33)	...	34·70	...	35·15	...	35·42
(34)	...	9·65	...	9·30	...	9·04
(35)	...	21·19	...	21·12	...	21·10
(37)	...	38·08	...	38·25	...	38·52
(42)	...	57·58	...	57·60	...	57·55

From the comparisons by coincident beats and the corrections of (43) found by observations, the corrections of (36) to local mean time are as follow :—

Epoch by (36)		Correction of (36) to mean time at the Government station		
h.	m.	h. m. s.		s.
7	11·0	+1 59 27·06	Hourly rate	−0·015
12	26·4	26·98		

Correction of (43) *to sidereal time at Lord Lindsay's station.*

h. m.		h. m. s.		s.
At 10 5·5 by chronometer . .	Chronometer correction =	−1 37 20·76	*Hourly* rate	+0·082

Whence—

Epoch by (36)		Correction of (36) to mean time at Lord Lindsay's station		
h.	m.	h. m. s.		
10	2·0	+1 59 26·65		

From the comparisons with (36) at the Government station, we get the corrections of the chronometers (in seconds) to mean time at the Government station, and from these we interpolate the correction for the intermediate epoch, $10^h\ 2^m{\cdot}0$ by (36), as follows :—

Compared chronometer	Time by (36)	Correction of compared chronometer	Time by (36)	Correction of compared chronometer	Resulting hourly rate	Interpolated correction of compared chronometer at $10^h\ 2^m{\cdot}0$ by (36)
	h. m.	s.	h. m.	s.	s.	s.
(30)	7 9	+ 32·61	12 26	+ 30·36	− 0·426	+ 31·38
(32)	...	59·98	...	59·30	− 0·129	59·61
(33)	...	52·36	...	51·56	− 0·151	51·92
(34)	...	17·41	...	17·94	+ 0·100	17·70
(35)	...	5·87	...	5·88	+ 0·002	5·88
(37)	...	48·98	...	48·46	− 0·098	48·70
(42)	...	29·48	...	29·43	− 0·009	29·45

With these corrections we find that of (36) to local mean time at the Government station by each chronometer :—

Correction of Chronometer 36 *to*

	Mean time at the Government station			Mean time at Lord Lindsay's station		
	h.	m.	s.	h.	m.	s.
By (30)	+ 1	59	26·98		...	
(32)			26·96		...	
(33)			27·07		...	
(34)			27·00		...	
(35)			27·00		...	
(37)			26·95		...	
(42)			27·05		...	
(43)			27·03		...	
By its own rate			27·02		...	
Mean	+ 1	59	27·006	+ 1	59	26·650

	h.	m.	s.
Therefore difference of time	= 0	0	0·36
Personal equation in observing with transit and altazimuth * . .	=		− 0·04

* Details of this determination will be found in Chapter XIX.

Therefore—

	h.	m.	s.
The British Government station is east of Lord Lindsay's station . .	0	0	0·32

CHAPTER XVI.

OPERATIONS AT ALEXANDRIA.

The observations at Alexandria were made principally to ascertain the corrections of the chronometers used in the exchanges of telegraphic longitude signals with Suez, Malta, and Berlin; but Dr. Löw remaining at Alexandria for a short time on his way to Malta, the opportunity was taken to make another determination of the difference of personal equation between Dr. Löw observing with his own transit instrument and Mr. Gill observing with the altazimuth. Mr. Gill also took a set of observations with Dr. Löw's transit instrument to determine his own personal equation in observing with that instrument and the altazimuth.

The weather being generally fine, a good series of time determinations were obtained, but on some occasions these were not sufficiently near to the times of exchange of signals. In these cases the comparisons of the stationary chronometers with the one used in the observations have been employed to carry on the time.

Unfortunately the roof of the Hôtel de l'Europe, where the instruments were mounted, was not sufficiently firm, and some of the observations (notably February 23 to February 27), in spite of the care which was taken, are not entirely satisfactory. It is hoped, however, that the simple means of the various groups will give results not very far from the truth; at least, they have been considered more reliable than any corrections that could be deduced by the aid of the stationary chronometers, which at best could but imperfectly reproduce the time determinations of other nights on which the observations have the appearance of greater accordance. This unsteadiness of the roof is plainly shown in the observations with Dr. Löw's transit instrument on March 3. The instrument being what is called a 'broken transit,' the observer was obliged to stand at the side to observe, and when he shifted his position from one side to the other, a change took place in the correction for level to the extent of ten seconds of arc.

On the following pages are given the original chronometer comparisons and time observations, together with their reductions and the resulting differences of longitude between Alexandria-Malta and Alexandria-Berlin (direct), also the final result of difference of personal equation in time observations between Dr. Löw and Mr. Gill

The subjoined chronometer comparisons were made for the purpose of carrying on the time in the event of the interval between the observations proving too great to trust solely to the rate of the observing chronometer. The whole of the comparisons are given just as they were made, although they have not all been actually used in the reductions.

The comparisons marked 'Est.' indicate that they have been made by estimation; the others are by coincident beats.

1875, February 19.

Before observations (1st group).

(43)			(36)		
h.	m.	s.	h.	m.	s.
6	37	20·0	6	31*	49·0
6	40	26·0	6	33	54·5

After observations (1st group).

(43)			(36)		
h.	m.	s.	h.	m.	s.
8	7	3·0	8	0	17·5
8	10	10·0	8	3	24·0

* Should probably be 30m.

On arrival at Telegraph Office, compared.

(43)			(36)		
h.	m.	s.	h.	m.	s.
8	51	0·0	8	44	7·5

SIGNALS EXCHANGED WITH SUEZ.

After exchange of signals.

(43)			(36)		
h.	m.	s.	h.	m.	s.
10	8	49·0	10	1	44·0
10	11	55·5	10	4	50·0

After return to Hotel.

(43)			(36)		
h.	m.	s.	h.	m.	s.
10	24	13·5	10	17	6·0

After observations (2nd group).

(43			(36)				h.	m.	s.		s.	
h.	m.	s.	h.	m.	s.	(36)	12	6	0·00	(30)	3·5	Est.
12	6	2·0	11	58	38·0						3·5	
12	9	6·5	12	1	42·0			,,		(32)	32·4	,,
											32·3	
								,,		(33)	47·55	,,
											47·6	
								,,		(34)	45·3	,,
											45·1	
								,,		(35)	16·5	,,
											16·5	
								,,		(37)	48·6	,,
											48·6	
								,,		(42)	49·0	,,
											49·0	

1875, February 20.

fore observations (1st group).

(43)			(36)		
h.	m.	s.	h.	m.	s.
6	43	10·0	6	32	46·0
6	46	14·5	6	35	50·0

After observations (1st group).

(43)			(36)		
h.	m.	s.	h.	m.	s.
8	6	23·0	7	55	45·5
8	9	26·0	7	58	48·0

On arrival at Telegraph Office, compared.

(43)			(36)		
h.	m.	s.	h.	m.	s.
8	25	5·0	8	14	24·5

SIGNALS EXCHANGED WITH SUEZ.

After exchange of signals.

(43)			(36)		
h.	m.	s.	h.	m.	s.
9	42	31·0	9	31	38·0
9	45	32·0	9	34	38·5

On return from Telegraph Office.

(43)			(36)		
h.	m.	s.	h.	m.	s.
10	1	12·0	9	50	16·0
10	4	17·0	9	53	20·5

After observations (*2nd group*).

(43)			(36)		
h.	m.	s.	h.	m.	s.
12	7	29·5	12	56	13·0
12	10	34·0	12	59	17·0

	h.	m.	s.			
(36)	12	0	0·00	(30)	12·0 12·1	Est.
,,				(32)	32·0 32·0	,,
,,				(33)	49·3 49·3	,,
,,				(34)	42·4 42·4	,,
,,				(35)	15·5 15·5	,,
,,				(37)	49·5 49·6	,,
,,				(42)	47·5 47·5	,,

1875, FEBRUARY 23.

Before observations (*1st group*).

(43)			(36)		
h.	m.	s.	h.	m.	s.
6	37	18·0	6	15	18·0
6	40	24·5	6	18	24·0

After observations (*1st group*).

(43)			(36)		
h.	m.	s.	h.	m.	s.
8	49	58·5	8	27	37·0
8	53	5·0	8	30	43·0

On arrival at Telegraph Office, compared.

(43)			(36)		
h.	m.	s.	h.	m.	s.
9	8	48·5	8	46	24·0
9	11	59·0	8	49	34·0

SIGNALS EXCHANGED WITH SUEZ.

After exchange of signals.

(43)			(36)		
h.	m.	s.	h.	m.	s.
10	11	15·0	9	48	40·5
10	14	21·0	9	51	46·0

On arrival at Hotel.

(43)			(36)		
h.	m.	s.	h.	m.	s.
10	27	4·0	10	4	27·0
10	30	10·0	10	7	32·5

After observations (2nd group).

(43)			(36)		
h.	m.	s.	h.	m.	s.
12	5	35·0	11	42	42·0
12	8	41·0	11	45	47·5

	h.	m.	s.		s.	
(36)	11	52	0·00	(30)	38·4 38·5	Est.
	,,			(32)	31·0 31·1	,,
	,,			(33)	54·8 54·9	,,
	,,			(34)	34·3 34·2	,,
	,,			(35)	12·4 12·4	,,
	,,			(37)	51·6 51·6	,,
	,,			(42)	42·8 42·75	,,

1875, February 24.

Cloudy, no chance of observations; chronometers compared.

(43)			(36)		
h.	m.	s.	h.	m.	s.
8	39	34·5	8	13	23·0
8	42	43·0	8	16	31·0

Signals exchanged with Suez.

After exchange of signals.

(43)			(36)		
h.	m.	s.	h.	m.	s.
10	28	29·0	10	2	0·0
10	31	34·0	10	5	5·0

On return to Hotel.

(43)			(36)		
h.	m.	s.	h.	m.	s.
10	44	6·0	10	17	34·5
10	47	13·0	10	20	41·0

	h.	m.	s.		s.	
(36)	10	35	00·0	(30)	46·5 46·6	Est.
	,,			(32)	30·9 31·0	,,
	,,			(33)	56·5 56·5	,,
	,,			(34)	31·7 31·8	,,
	,,			(35)	11·1 11·1	,,
	,,			(37)	52·2 52·2	,,
	,,			(42)	41·5 41·5	,,

(43)			(36)		
h.	m.	s.	h.	m.	s.
11	9	29·0	10	43	53·5
11	12	36·0	10	46	0·0

1875, February 25.

Before observations (1st group).

(43)			(36)		
h.	m.	s.	h.	m.	s.
6	56	1·0	6	26	14·5
6	59	8·0	6	29	21·0

After observations (1st group).

(43)			(36)		
h.	m.	s.	h.	m.	s.
8	50	13·0	8	20	8·0
8	53	22·5	8	23	17·0

On arrival at Telegraph Office, compared.

(43)			(36)		
h.	m.	s.	h.	m.	s.
9	5	33·5	8	35	26·0
9	8	38·0	8	38	30·0

On account of some telegraphic fault no exchange of signals with Suez was possible; compared again.

(43)			(36)		
h.	m.	s.	h.	m.	s.
10	50	51·5	10	20	27·0
10	53	58·0	10	23	33·0

On arrival at Hotel.

(43)			(36)				h.	m.	s.		s.	
h.	m.	s.	h.	m.	s.							
11	6	59·0	10	36	32·0	(36)	10	50	0·00	(30)	55·6 55·4	Est.
11	10	5·5	10	39	38·0							
								,,		(32)	30·8 30·8	,,
								,,		(33)	57·8 57·9	,,
								,,		(34)	29·05 29·1	,,
								,,		(35)	9·7 9·8	,,
								,,		(37)	52·9 52·9	,,
								,,		(42)	39·7 39·7	,,

1875, FEBRUARY 27.

Before observations.

							h.	m.	s.		s.	
						(36)	9	12	0·00	(30)	11·5 11·5	Est.
								,,		(32)	30·5 30·5	,,
								,,		(33)	0·1 0·2	,,
								,,		(34)	23·8 23·9	,,
								,,		(35)	7·5 7·5	,,
(43)			(36)					,,		(37)	54·4 54·4	,,
h.	m.	s.	h.	m.	s.							
9	55	56·0	9	17	57·0							
9	59	2·0	9	21	2·5			,,		(42)	36·6 36·6	,,

After observations.

(43)			(36)								
h.	m.	s.	h.	m.	s.		h.	m.	s.		
12	24	54·0	11	46	31·0	(36)	11	51	0·00	(30)	12·5 12·6 } Est.
						„				(32)	30·5 30·5 } „
						„				(33)	0·4 0·5 } „
						„				(34)	23·6 23·55 } „
						„				(35)	7·3 7·3 } „
(43)			(36)			„				(37)	54·4 54·4 } „
h.	m.	s.	h.	m.	s.						
12	34	5·5	11	55	41·0						
12	37	12·0	11	58	47·0	„				(42)	36·5 36·5 } „

On arrival at Telegraph Office, compared.

(43)			(36)		
h.	m.	s.	h.	m.	s.
12	56	52·0	12	17	24·0
12	59	0·5	12	20	32·0
13	2	9·0	12	23	40·0

1875, February 28.

Before observations (1st group).

(43)			(36)		
h.	m.	s.	h.	m.	s.
9	36	31·0	8	54	43·5
9	39	36·0	8	57	48·0

After observations (1st group).

(43)			(36)								
h.	m.	s.	h.	m.	s.		h.	m.	s.		
11	40	1·5 *	10	57	54·0	(36)	11	6	0·00	(30)	20·6 20·6 } Est.
11	43	7·0	11	0	59·0	„				(32)	30·5 30·5 } „
						„				(33)	1·3 1·3 } „
						„				(34)	21·0 21·1 } „
						„				(35)	6·0 6·0 } „
(43)			(36)			„				(37)	55·0 55·0 } „
h.	m.	s.	h.	m.	s.						
11	52	13·5	11	10	4·0						
11	55	20·0	11	13	10·0	„				(42)	34·8 34·9 } „

On arrival at Telegraph Office, compared.

(43)			(36)		
h.	m.	s.	h.	m.	s.
12	17	14·5	11	35	1·0
12	20	20·0	11	38	6·0

* 18·0 in original.

SIGNALS EXCHANGED WITH BERLIN.

Between exchange of signals.

(43			(36)		
h.	m.	s.	h.	m.	s.
14	40	21·0	13	57	44·5
14	43	27·0	14	0	50·0
[15	5	10·0	14	22	34·5*]
15	8	15·0	14	25	39·0

[*] These comparisons are wrong; rejected.

After exchange of signals.

(43)			(36)		
h.	m.	s.	h.	m.	s.
16	22	16·0	15	39	23·0
16	25	21·0	15	42	27·5

Before observations (2nd group).

(43)			(36)		
h.	m.	s.	h.	m.	
16	37	39·0	15	54	43·
16	40	45·0	15	57	49·

After observations (2nd grou

(43)			(36)		
h.	m.	s.	h.	m.	s.
17	27	1·5	16	43	58·0
17	30	8·0	16	47	4·0

	h.	m.	s.		s.	
(36)	16	52	0·00	(30)	22·8	Est.
					22·7	
		"		(32)	30·4	"
					30·5	
		"		(33)	1·5	"
					1·5	
		"		(34)	20·4	"
					20·4	
		"		(35)	5·8	"
					5·8	
		"		(37)	55·4	"
					55·35	
		"		(42)	34·4	"
					34·4	

1875, *March* 3.—The following comparisons were made between the observing chronometers of Dr. Löw and Mr. Gill for the determination of personal equation, Dr. Löw using Nieberg; Mr. Gill using (43):—

Nieberg			(43)		
h.	m.	s.	h.	m.	s.
11	27	39·0	8	44	31·0
11	33	40·0	8	50	33·0

Nieberg			(43)		
h.	m.	s.	h.	m.	s.
13	38	14·0	10	55	27·5
13	41	15·0	10	58	29·0

Nieberg			(43)		
h.	m.	s.	h.	m.	s.
15	36	37·0	12	54	10·0
15	39	40·0	12	57	13·5
15	42	42·0	13	0	16·0
15	45	54·5	13	3	29·0

After all the observations.

(43)			(36)		
h.	m.	s.	h.	m.	s.
13	10	40·0	12	16	42·0
13	13	48·0	12	19	49·5

	h.	m.	s.		s.	
(36)	12	21	0·00	(30)	46·5 46·5	Est.
		„		(32)	30·8 30·8	„
		„		(33)	3·5 3·5	„
		„		(34)	13·0 13·0	„
		„		(35)	2·5 2·5	„
		„		(37)	57·5 57·4	„
		„		(42)	29·0 29·0	„

1875, *March* 6.—No observations for time. The chronometer comparisons were :—

	h.	m.	s.		s.	
(36)	10	13	0·00	(30)	10·8 10·9	Est.
		„		(32)	31·4 31·4	„
		„		(33)	5·6 5·6	„
		„		(34)	5·9 5·8	„
		„		(35)	58·8 58·8	„
		„		(37)	59·4 59·4	„
		„		(42)	23·6 23·6	„

(43)			(36)		
h.	m.	s.	h.	m.	s.
11	23	30·5	10	18	15·0
11	26	36·0	10	21	20·0
11	29	42·5	10	24	26·0

On arrival at Telegraph Office, compared.

(43)			(36)		
h.	m.	s.	h.	m.	s.
12	4	15·0	10	58	53·0
12	7	20·5	11	1	58·0

(43)			(36)		
h.	m.	s.	h.	m.	s.
13	15	25·0	12	9	51·5
13	18	33·0	12	12	59·0
13	24	42·0	12	19	7·0

SIGNALS EXCHANGED WITH BERLIN.

After exchange of signals with Berlin.

(43)			(36)		
h.	m.	s.	h.	m.	s.
14	45	8·0	13	39	20·0
14	48	12·0	13	42	23·5

SIGNALS EXCHANGED WITH MALTA.

After exchange of signals with Malta.

(43)			(36)		
h.	m.	s.	h.	m.	s.
15	43	49·0	14	37	51·5
15	46	55·0	14	40	57·0

After return from Telegraph Office.

(43)			(36)		
h.	m.	s.	h.	m.	s.
16	2	20·5	14	56	20·0
16	5	25·0	14	59	24·0

	h.	m.	s.		s.	
(36)	15	7	0·00	(30)	12·8 12·8	Est.
				(32)	31·4 31·5	„
				(33)	5·8 5·8	„
				(34)	5·5 5·6	„
				(35)	58·6 58·6	„
				(37)	59·6 59·6	„
				(42)	23·4 23·4	„

1875, *March* 7.—No observations for time. The chronometer comparisons were :—

	h.	m.	s.		s.	
(36)	8	29	0·00	(30)	19·0 19·1	Est.
				(32)	32·0 32·0	„
				(33)	6·6 6·7	„
				(34)	3·8 3·8	„
				(35)	57·6 57·6	„
				(37)	0·1 0·1	„
				(42)	22·1 22·1	„

(43)			(36)		
h.	m.	s.	h.	m.	s.
9	44	12·0	8	35	20·5
9	47	18·0	8	38	26·0
9	50	25·0	8	41	32·5

Before going to Telegraph Office.

(43)			(36)		
h.	m.	s.	h.	m.	s.
12	6	36·5	10	57	22 0
12	9	41·0	11	0	26·0

After arrival at Telegraph Office.

(43)			(36)		
h.	m.	s.	h.	m.	s.
12	28	48·0	11	19	10·0
12	31	34·5	11	22	16·0

SIGNALS EXCHANGED WITH BERLIN.

After exchange of signals.

(43)			(36)		
h.	m.	s.	h.	m.	s.
15	3	24·0	13	53	41·0
15	9	35·0	13	59	51·0

After return from Telegraph Office.

(43) h.	m.	s.	(36) h.	m.	s.
15	37	15·0	14	27	26·5
15	40	21·0	14	30	32·0

	h.	m.	s.		s.	
(36)	14	36	0·00	(30)	21·2 21·3	Ešt.
		„		(32)	32·1 32·0	
		„		(33)	7·0 7·0	
		„		(34)	3·1 3·1	,
		„		(35)	57·5 57·4	,
		„		(37)	0·4 0·4	,
		„		(42)	21·7 21·7	„

1875, MARCH 10.

Before observations (1st group).

(43) h.	m.	s.	(36) h.	m.	s.
6	54	58·0	5	34	58·0
6	57	2·5	5	37	2·0
(43) 7	1	39·0	(30) 5	52	22·0
(43) 7	6	53·0	(32) 6	13	24·0
(43) 7	8	50·0	(33) 5	43	58·0
7	9†	58·0	5	47	5·5
(43) 7	14	35·5	(34) 5	36	29·0
(43) 7	17	7·0	(35) 5	48	58·0
(43) 7	20	59·5	(37) 5	55	58·0
(43) 7	25	8·0	(42) 5	55	21·0

* Should probably be 57m.

After observations (1st group).

(43) h.	m.	s.	(36) h.	m.	s.
8	42	53·5	7	22	36·0
8	45	59·0	7	25	41·0
(43) 8	50	37·0	(30) 7	41	3·0
8	53	51·0	7	44	16·5
8	56*	4·0	7	47	29·0
(43) 8	58	48·0	(32) 8	5	1·0
9	1	54·0	8	8	6·5
(43) 9	7	3·0	(33) 7	41	52·0
9	10	10·5	7	44	59·0
(43) 9	16	38·5	(34) 7	38	12·0
9	19	42·0	7	41	15·0
(43) 9	23	13·5	(35) 7	54	44·0
9	26	17·0	7	57	47·0
(43) 9	28	14·0	(37) 8	2	52·0
9	31	20·5	8	5	58·0
(43) 9	33	56·0	(42) 8	3	48·0
9	36	57·5	8	6	49·0
(43) 9	39	4·5	(36) 8	18	38·0
9	42	9·0	8	21	42·0

† Should probably be 11m.

After observations (2nd group).

(43) h.	m.	s.	(36) h.	m.	s.
11	42	34·0	10	21	47·5
11	45	39·0	10	24	52·0
(43) 11	50	44·0	(30) 10	40	42·0
11	57	5·0	10	47	2·0
(43) 12	1	24·5	(32) 11	7	8·0
(43) 12	4	38·0	(33) 10	38	58·5
(43) 12	7	48·0	(34) 10	28	53·5
(43) [12	12	36·0	(35) 10	43	6·0‡]
12	15	42·0	10	46	44·6§
(43) 12	19	14·0	(37) 10	53	24·5
(43) 12	22	49·0	(42) 10	52	13·5
12	25	54·0	10	55	18·0
(43) 12	29	24·0	(36) 11	8	30·0
12	32	33·0	11	11	38·5

[‡] This comparison wrong; not used.

§ Should probably be 44s·5.

On arrival at Telegraph Office, compared.

(43)			(36)		
h.	m.	s.	h.	m.	s.
12	48	23·0	11	27	26·0
12	51	30·0	11	30	32·5
12	54	36·0	11	33	38·0

SIGNALS EXCHANGED WITH MALTA.

After exchange of signals with Malta.

(43)			(36)		
h.	m.	s.	h.	m.	s.
15	24	14·0	14	2	52·0
15	27	18·5	14	5	56·0

SIGNALS EXCHANGED WITH BERLIN.

After exchange of signals with Berlin.

(43)			(36)		
h.	m.	s.	h.	m.	s.
17	22	26·0	16	0	45·0
17	25	30·0	16	3	48·5

After return to Hotel.

	h.	m.	s.		h.	m.	s.
(43)	17	56	31·0	(36)	16	34	44·5
	17	59	35·0		16	37	48·0
(43)	18	2	9·0	(30)	16	51	9·5
(43)	18	4	25·0	(32)	17	9	10·0
(43)	18	6	57·0	(33)	16	40	19·5
(43)	18	10	20·0	(34)	16	30	26·5
(43)	18	14	17·0	(35)	16	44	21·5
(43)	18	18	14·0	(37)	16	51	27·0
(43)	18	20	52·0	(42)	16	49	18·5

1875, MARCH 11.

Before observations (*1st group*).

(43)			(36)		
h.	m.	s.	h.	m.	s.
6	59	0·0	5	35	7·5
7	2	8·0	5	38	15·0

After observations (*1st group*).

	h.	m.	s.		h.	m.	s.
(43)	8	49	53·5	(36)	7	25	43·0
	8	53	0·0		7	28	49·0
(43)	8	57	25·5	(30)	7	44	7·0
(43)	9	0	49·0	(32)	8	3	10·0
(43)	9	2	25·0	(33)	7	33	24·0
(43)	9	5	35·5	(34)	7	23	16·0
(43)	9	9	27·5	(35)	7	37	7·0
	9	12	34·0		7	40	13·0
(43)	9	15	48·0	(37)	7	46	37·0
(43)	9	17	36·0	(42)	7	43	37·0

Before observations (2nd group).

(43)			(36)		
h.	m.	s.	h.	m.	s.
10	44	46·0	9	20	17·0
10	47	51·5	9	23	22·0

After observations (2nd group).

(43)			(36)			(43)			(35)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
12	23	11·0	10	58	26·0	12	29	27·0	10	56	34·0
12	26	17·0	11	1	31·5	12	32	31·0	10	59	37·5

On arrival at Telegraph Office, compared.

(43)			(36)		
h.	m.	s.	h.	m.	s.
12	51	0·0	11	26	10·5
12	54	4·0	11	29	14·0

SIGNALS EXCHANGED WITH MALTA.

After exchange of signals.

(43)			(36)		
h.	m.	s.	h.	m.	s.
15	13	47·5	13	48	35·0
15	16	55·0	13	51	42·0

On arrival at Hotel.

(43)			(36)		
h.	m.	s.	h.	m.	s.
15	28	59·0	14	3	44·0
15	32	4·5	14	6	49·0

After observations (3rd group).

(43)			(36)			(43)			(35)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
16	39	50·5	15	14	24·0	16	45	16·0	15	11	41·5
16	42	56·0	15	17	29·0	16	48	20·0	15	14	45·0

1875, MARCH 12.

Before observations (1st group).

(43)			(36)		
h.	m.	s.	h.	m.	s.
6	41	55·0	5	14	13·0
6	45	1·0	5	17	18·5

After observations (1st group).

	h.	m.	s.		h.	m.	s.
(43)	9	7	47·5 }	(36)	7	39	42·0 }
	9	10	54·0 }		7	42	48·0 }
(43)	9	14	18·0	(30)	7	57	13·0
(43)	9	17	32·0	(32)	8	15	59·0
(43)	9	19	33·0	(33)	7	46	38·5
(43)	9	22	21·0	(34)	7	36	4·0
(43)	9	23	44·0 }	(35)	7	47	28·0 }
	9	26	49·5 }		7	50	33·0 }
(43)	9	30	42·5	(37)	7	57	38·0
(43)	9	32	34·0	(42)	7	54	31·0

After observations (2nd group).

(43)			(36)			(43)			(35)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
12	23	47·0	10	55	10·0	12	29	25·0	10	52	39·0
12	26	53·0	10	58	15·5	12	32	30·0	10	55	43·5

On arrival at Telegraph Office, compared.

(43)			(36)		
h.	m.	s.	h.	m.	s.
12	45	39·0	11	16	58·5
12	48	46·0	11	20	5·0

Signals exchanged with Malta.

After exchange of signals with Malta.

(43)			(36)		
h.	m.	s.	h.	m.	s.
15	28	5·5	13	58	59·0
15	37	28·0	14	8	20·0

Signals exchanged with Berlin.

Between exchange of signals with Berlin.

(43)			(36)		
h.	m.	s.	h.	m.	s.
17	57	42·0	16	28	11·5
18	4*	52·0	16	34	20·5

* Should probably be 3m.

After exchange of signals with Berlin.

(43)			(36)		
h.	m.	s.	h.	m.	s.
18	41	4·0	17	11	26·5
18	44	11·0	17	14	33·0

On arrival at Hotel.

	h.	m.	s.		h.	m.	s.
(43)	18	56	22·0	(36)	17	26	42·0
	18	59	27·0		17	29	46·5
(43)	19	1	28·0	(30)	17	42	52·0
(43)	19	2	30·0	(32)	17	59	23·0
(43)	19	5	7·0	(33)	17	30	39·0
(43)	19	7	5·0	(34)	17	19	13·0
(43)	19	8	42·0	(35)	17	30	51·5
	19	11	49·0		17	33	58·0
(43)	19	15	43·0	(37)	17	41	5·0
(43)	19	19	34·0	(42)	17	40	4·0

1875, March 13.

Between the 1st and 2nd groups of observations.

	h.	m.	s.		h.	m.	s.
(43)	9	59	43·5	(36)	8	27	38·0
	10	2	53·0		8	30	47·0
(43)	10	13	23·0	(30)	8	52	25·5
(43)	10	16	51·0	(32)	9	11	17·0
(43)	10	20	45·0	(33)	8	43	50·5
(43)	10	24	25·5	(34)	8	34	4·0
(43)	10	26	3·0	(35)	8	45	44·0
	10	29	11·5*		8	48	52·0
(43)	10	33	41·0	(37)	8	56	36·0
(43)	10	35	2·5	(42)	8	53	4·0

* 11·5 in original.

After observations (2nd group).

(43)			(36)			(43)			(35)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
12	23	2·5	10	50	34·0	12	29	56·0	10	49	17·0
12	26	7·0	10	53	38·0	12	33	0·0	10	52	20·5
						12	36	7·0	10	55	27·0

On arrival at Telegraph Office, compared.

(43)			(36)		
h.	m.	s.	h.	m.	s.
12	51	7·0	11	18	34·0
12	54	16·0	11	21	42·5

Signals exchanged with Malta.

After exchange of signals with Malta.

(43)			(36)		
h.	m.	s.	h.	m.	s.
14	9	6·0	12	36	20·5
14	21	34·0	12	48	46·5

Signals exchanged with Berlin.

After exchange of signals with Berlin.

(43)			(36)		
h.	m.	s.	h.	m.	s.
15	58	2·0	14	24	59·0
16	4	16·0	14	31	12·0

On arrival at Hotel.

(43)			(36)		
h.	m.	s.	h.	m.	s.
16	19	35·5	14	46	29·0
16	22	45·0	14	49	38·0

After observations (3rd group).

(43)			(36)			(43)			(35)		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
17	27	28·5	15	54	11·0	17	33	8·0	15	51	40·0
17	30	35·0	15	57	17·0	17	36	13·0	15	54	44·5

1875, MARCH 14.

Before observations.

	h.	m.	s.		h.	m.	s.
(43)	9	51	36·0	(36)	8	15	40·5
	9	54	41·0		8	38*	45·0
(43)	9	58	5·0	(35)	8	13	58·0
	10	4	16·0		8	20	8·0
(43)	10	7	33·0	(42)	8	21	46·0
	10	10	39·0		8	24	51·5

After observations.

	h.	m.	s.		h.	m.	s.
(43)	12	2	25·5	(36)	10	26	9·0
	12	5	33·0		10	29	16·0
(43)	12	11	18·5	(35)	10	26	50·0
	12	17	31·5		10	33	2·0
(43)	12	23	39·0	(42)	10	37	30·0
	12	26	45·5		10	40	36·0

* Should probably be 18m.

On arrival at Telegraph Office, compared.

(43)			(36)		
h.	m.	s.	h.	m.	s.
12	58	26·5	11	22	1·0
13	1	37·0	11	25	11·0

SIGNALS EXCHANGED WITH MALTA.

After exchange of signals with Malta.

(43)			(36)		
h.	m.	s.	h.	m.	s.
14	35	17·0	12	58	36·0
14	38	25·0	13	1	43·5

SIGNALS EXCHANGED WITH BERLIN.

After exchange of signals with Berlin.

(43)			(36)		
h.	m.	s.	h.	m.	s.
16	55	17·5	15	18	14·0
16	58	23·0	15	21	19·0

After return to Hotel.

	h.	m.	s.		h.	m.	s.
(43)	17	13	38·5	(36)	15	36	32·0
	17	16	44·0		15	39	37·0
(43)	17	21	17·5	(35)	15	35	59·0
	17	24	22·0		15	39	3·0
(43)	17	26	46·0	(42)	15	39	48·0
	17	29	52·0		15	42	53·5

Time Determinations at Alexandria.

The observations of time stars in the vertical of the Pole star were taken with the Troughton and Simms' altazimuth.

Observer, Mr. Gill; Chronometer 43.

Date, 1875	Pole star	Position of circle	Chronometer time of Pole star on wire III.	Level readings	Time star	Chronometer times of transit over wires					Level readings
						I.	II.	III.	IV.	V.	
			h. m. s.	E p. / W p.		s.	s.	h. m. s.	s.	s.	E p. / W p.
Feb. 19, 1st group*	α Ursæ min.	W	6 50 30·0	26·1 / 12·4 16·0 / 22·5	α Canis maj.	10·5	25·0	6 55 38·6	52·4	6·3	26·4 / 12·2 15·9 / 22·8
	α Ursæ min.	W	7 5 0·0	25·2 / 13·2 15·3 / 23·2	63 Aurigæ	27·5	45·3	7 25 2·3	19·8	36·9	23·8 / 14·9 17·2 / 21·6
	α Ursæ min.	E	7 32 46·0	24·0 / 14·5 16·4 / 22·0	65 Aurigæ	47·8	30·8	7 35 14·0	57·5	41·3	... / ...
	α Ursæ min.	W	7 47 25·0	16·0 / 22·6 26·5 / 12·1	*f* Geminorum	4·8	18·9	7 51 32·9	46·8	0·9	23·3 / 15·7 16·8 / 22·0
	„ „	„	„	„ / „	*π* Geminorum	3·2	19·5	8 0 35·4	51·1	7·2	24·7 / 13·9 16·2 / 22·5
Feb. 19, 2nd group	α Ursæ min.	W	10 31 24·5	13·5 / 25·2 24·5 / 14·6	33 Leonis min.	11·4	27·8	10 45 43·5	59·0	15·1	22·0 / 17·3 15·5 / 23·7
	α Ursæ min.	E	10 53 9·0	22·4 / 16·8 15·6 / 23·4	42 Leonis min.	11·0	55·0	10 59 39·5	24·2	8·4	18·8 / 20·0 20·4 / 18·7
	„ „	„	„	„ / „	46 Leonis min.	55·0	38·5	11 7 22·3	6·4†	50·0	21·5 / 17·6 15·2 / 24·0
	α Ursæ min.	W	11 14 18·0	22·5 / 16·6 14·3 / 24·7	*ψ* Ursæ maj.	1·0	20·2	11 24 38·9	57·4	16·4	13·3 / 26·2 25·2 / 14·1
	„ „	„	„	„ / „	*ξ* Ursæ maj.	51·5	7·6	11 32 23·5	39·0	...	22·0 / 17·3 14·0 / 25·0
	α Ursæ min.	E	11 38 48·0	24·7 / 14·5 14·0 / 25·0	61 Ursæ maj.	58·9	42·3	11 55 26·2	10·1	54·0	14·7 / 25·0 23·8 / 15·6
Feb. 20, 1st group	α Ursæ min.	E	7 1 0·0	13·2 / 23·6 22·5 / 14·5	*θ* Geminorum	...	54·1	7 5 38·2	22·3	6·1	22·6 / 14·0 14·0 / 22·8
	α Ursæ min.	W	7 13 52·0	13·3 / 23·2 23·0 / 13·7	63 Aurigæ	25·5	43·2	7 25 0·5	...	...	22·8 / 14·2 13·0 / 24·0
	„ „	„	„	„ / „	65 Aurigæ	42·0	59·2	7 35 15·3	32·0	...	„ / „
	„ „	„	„	„ / „	63 Geminorum	...	...	7 39 57·7	11·7	26·2	„
	α Ursæ min.	E	7 48 37·0	23·8 / 13·3 13·3 / 23·3	*f* Geminorum	54·3	40·0	7 51 26·1	12·2	58·4	13·0 / 24·1 23·5 / 13·5
	„ „	„	„	„ / „	*π* Geminorum	1·3	45·1	8 0 29·2	13·5	57·4	12·7 / 24·5 23·1 / 13·6
Feb. 20, 2nd group	α Ursæ min.	E	10 13 1·0	24·5 / 12·6 11·0 / 25·3	Piazzi IX. 254	52·2	34·3	10 25 16·4	59·1	41·2	24·7 / 12·7 12·7 / 24·5
	„ „	„	„	„ / „	*μ* Ursæ maj.	25·4	7·0	10 36 49·2	31·7	13·9	„ / „
	„ „	„	„	„ / „	33 Leonis min.	10·9	54·8	10 45 ...	23·2	7·4	13·3 / 23·5 23·5 / 13·5
	α Ursæ min.	W	10 53 44·0	13·5 / 24·1 23·3 / 14·0	42 Leonis min.	9·5	25·8	10 59 41·4	56·7	12·1	19·5 / 17·5 18·0 / 19·0
	„ „	„	„	„ / „	46 Leonis min.	51·3	7·5	11 7 ...	40·1	56·2	16·8 / 20·2 22·3 / 15·0
	α Ursæ min.	E	11 15 37·0	12·2 / 24·9 25·0 / 12·0	*ξ* Ursæ maj.	49·4	33·3	11 32 17·7	...	46·6	26·0 / 11·2 12·2 / 25·1
	α Ursæ min.	W	11 40 12·0	12·3 / 25·2 25·0 / 12·5	58 Ursæ maj.	47·9	6·4	11 45 25·0	42·8	1·5	24·9 / 12·7 13·5 / 23·8
	„ „	„	„	„ / „	61 Ursæ maj.	55·1	12·0	11 55 ...	...	0·4	13·8 / 23·5 23·6 / 13·7
Feb. 23, 1st group	α Ursæ min.	E	6 52 35·0	... / ...	*ε* Geminorum	38·2	23·1	6 56 8·4	54·0	39·0	15·6 / 22·2 26·1 / 11·7
	„ „	„	„	... / ...	*θ* Geminorum	6·4	50·0	7 6 34·2	18·1	2·0	25·5 / 12·3 16·1 / 21·4

* All observations bad, from wind affecting illumination and a band playing in the square.

† 5ˢ·4 in original.

OBSERVER, MR. GILL; CHRONOMETER 43 (*continued*).

Date, 1875	Pole star	Position of circle	Chronometer time of Pole star on wire III.	Level readings	Time star	Chronometer times of transit over wires					Level readings
						I.	II.	III.	IV.	V.	
			h. m. s.	E p. / W p.		s.	s.	h. m. s.	s.	s.	E p. / W p.
Feb. 23, 1st group (*cont.*)	α Ursæ min.	W	7 13 24·0	15·3 / 22·6 25·2 / 12·5	ζ Geminorum	39·3	53·9	7 16 8·1	22·2	36·4	24·8 / 13·0 16·0 / 21·6
	" " "	"	"	" / "	63 Aurigæ	20·6	38·0	7 24 55·3	12·5	29·5	25·0 / 12·6 14·0 / 24·0
	α Ursæ min.	E	7 36 40·0	23·3 / 14·6 16·5 / 21·3	63 Geminorum	17·0	2·8	7 39 48·3	34·3	20·0	25·3 / 12·8 13·4 / 24·5
	α Ursæ min.	W	7 47 1·0	24·1 / 13·7 13·0 / 25·0	*f* Geminorum	55·3	9·8	7 51 24·0	37·9	51·5	16·1 / 22·0 25·0 / 13·1
	α Ursæ min.	E	8 4 38·0	22·4 / 15·3 14·5 / 23·3	6 Cancri	35·0	19·4	8 16 4·4	49·4	34·3	13·0 / 25·2 24·1 / 14·0
	" " "	"	"	" / "	ψ^2 Cancri	24·0	9·0	8 23 54·1	39·4	24·9	22·3 / 15·4 13·5 / 24·9
	α Ursæ min.	W	8 29 17·0	22·3 / 15·7 12·3 / 25·5	χ Cancri	11·5	26·8	8 32 32·0	56·5	11·6	22·9 / 15·2 12·2 / 26·0
	" " "	"	"	" / "	ϕ^1 Cancri	40·6	56·2	8 39 11·0	26·0	...	12·3 / 25·7 23·4 / 15·0 23·5 / 14·9 13·5 / 24·7
Feb. 23, 2nd group	α Ursæ min.	E	10 37 32·0	24·2 / 14·1 13·6 / 24·9	33 Leonis min.	4·9	48·4	10 45 32·8	17·2	1·1	18·2 / 20·2 22·8 / 16·0
	α Ursæ min.	W	10 54 50·5	14·2 / 24·4 24·9 / 13·9	42 Leonis min.	...	20·2	10 59 35·8	51·1	6·7	16·1 / 22·7 24·4 / 14·2
	" " "	"	"	" / "	46 Leonis min.	45·4	2·0	11 7* 18·3	34·35	50·4	25·0 / 13·8 14·5 / 24·0
	α Ursæ min.	E	11 15 40·5	18·8 / 19·8 22·2 / 16·5	ψ Ursæ maj.	6·7	47·0	11 24 28·4	9·9	51·0	21·1 / 17·6 15·2 / 23·3
	" " "	"	"	" / "	ξ Ursæ maj.	44·4	28·3	11 32 12·4	...	41·4	25·0 / 13·6 15·9 / 22·9
	α Ursæ min.	W	11 41 7·0	24·4 / 14·2 14·6 / 23·9	58 Ursæ maj.	...	...	11 45 18·9	37·3	55·5	15·0 / 23·6 24·1 / 14·6
	" " "	"	"	" / "	61 Ursæ maj.	49·2	5·8	11 55 ...	38·0	54·3	16·3 / 22·4 24·3 / 14·5
Feb. 25	α Ursæ min.	W	7 5 33·0	23·0 / 14·0 12·2 / 24·8	ζ Geminorum	35·0	49·2	7 16 3·6	17·3	31·8	19·9 / 17·5 16·0 / 21·3
	" " "	"	"	" / "	63 Aurigæ	15·8	23·3	7 24 50·7	...	24·9	15·5 / 22·1 21·2 / 16·1
	α Ursæ min.	E	7 35 22·0	22·3 / 15·0 13·4 / 24·0	63 Geminorum	13·2	58·3	7 39 34·0	29·8	15·4	22·5 / 15·1 12·0 / 25·6
	α Ursæ min.	W	7 46 53·0	12·4 / 25·2 23·4 / 14·3	*f* Geminorum	51·0	5·4	7 51 19·7	33·4	47·1	12·0 / 25·9 22·3 / 15·8
	α Ursæ min.	E	8 6 26·0	13·5 / 24·2 23·4 / 14·4	6 Cancri	30·3	15·0	8 16 0·0	45·0	29·9	12·7 / 25·3 22·1 / 15·9
	" " "	"	"	" / "	ψ^2 Cancri	19·5	4·4	8 22 49·9	35·2	20·5	23·0 / 15·0 13·2 / 25·0
	α Ursæ min.	W	8 29 10·0	23·4 / 14·9 14·0 / 24·1	χ Cancri	7·5	22·8	8 32 37·8	52·4	7·5	22·4 / 15·7 12·5 / 25·8
	" " "	"	"	" / "	ϕ^1 Cancri	36·4	52·0	8 39 6·9	21·8	36·9	14·6 / 23·9 23·2 / 15·1
Feb. 27	α Ursæ min.	E	10 11 13·5	23·4 / 14·9 13·0 / 25·5	Piazzi IX. 230	0·7	46·0	10 15 31·8	17·4	3·3	23·4 / 14·5 12·2 / 26·0
	" " "	"	"	" / "	Piazzi IX. 254	39·7	21·5	10 25* 3·8	46·4	28·5	24·2 / 14·1 13·0 / 25·4
	α Ursæ min.	W	10 32 35·5	14·2 / 24·1 23·0 / 15·4	μ Ursæ maj.	57·0	15·5	10 36 33·4	51·1	9·0	24·0 / 14·2 12·0 / 26·4
	" " "	"	"	" / "	33 Leonis min.	56·2	...	10 45 28·2	...	59·5	12·8 / 25·7 24·0 / 14·6
	α Ursæ min.	W	11 0 10·0	25·8 / 12·2 14·0 / 24·2	ψ Ursæ maj.	51·9	11·1	11 24 30·0	48·7	7·5	14·3 / 24·1 25·3 / 13·0
	" " "	"	"	" / "	ξ Ursæ maj.	36·5	52·5	11 32 8·1	23·9	...	24·5 / 14·0 13·9 / 24·6
	α Ursæ min.	E	11 42 9·0	15·9 / 22·6 23·1 / 15·3	61 Ursæ maj.	43·7	27·0	11 55 11·0	55·1	38·9	14·3 / 24·1 25·0 / 13·3

* Minute supplied.

OBSERVER, MR. GILL; CHRONOMETER 43 (*continued*).

Date, 1875	Pole star	Position of circle	Chronometer time of Pole star on wire III.			Level readings		Time star	Chronometer times of transit over wires						Level readings	
									I.	II.	III.			IV.	V.	
			h.	m.	s.	E p.	W p.		s.	s.	h.	m.	s.	s.	s.	E p.	W p.
Feb. 28, 1st group	α Ursæ min.	W	9	49	4·0	15·0 24·3	24·2 14·9	*f* Leonis	7·0	22·9	9	56	38·5	53·6	8·8	14·5 24·5	24·8 14·8
	,, ,,	,,		,,		,,	,,	μ Leonis	...	25·3	10	5	39·6	54·8	9·7	25·5 13·7	13·6 25·7
	α Ursæ min.	E	10	14	34·0	25·6 14·4	13·5 24·8	Piazzi IX. 254	38·0	19·9	10	25	2·3	44·9	27·4	15·5 25·1	23·8 14·1
	α Ursæ min.	E	10	32	5·0	25·8 15·2	13·6 24·1	μ Ursæ maj.	6·4	48·0	10	36	29·9	12·2	54·2	14·8 25·4	24·5 13·8
	,, ,,	,,		,,		,,	,,	33 Leonis min.	56·4	40·1	10	45	24·4	8·7	53·1	26·0 14·4	13·3 25·0
	α Ursæ min.	W	10	55	20·0	14·0 24·9	25·3 14·5	42 Leonis min.	53·4	9·2	10	59	24·9	40·4	55·9	22·8 15·2	16·3 24·0
	,, ,,	,,		,,		,,	,,	46 Leonis min.	34·6	51·0	11	7	7·1	23·2	39·4	15·1 25·0	24·2 14·2
	α Ursæ min.	E	11	19	10·0	25·5 15·0	13·8 24·2	ψ Ursæ maj.	56·4	36·7	11	24	17·9	59·5	40·4	16·4 24·0	22·9 15·2
	,, ,,	,,		,,		,,	,,	ξ Ursæ maj.	35·7	19·9	11	32	3·5	48·5	33·0	14·7 25·8	24·7 13·5
Feb. 28, 2nd group	α Ursæ min.	E	16	46	24·0	25·0 14·4	14·6 25·3	σ Herculis	51·4	33·0	16	49	14·8	...	...	16·9 25·2	23·1 14·8
	,, ,,	,,		,,		,,	,,	ζ Herculis	29·2	13·3	16	56	57·5	42·1	26·5	,,	,,
	α Ursæ min.	W	17	6	26·0	16·9 22·0	23·0 17·9	κ Ophiuchi	38·1	52·0	17	14	5·3	18·8	32·2	14·2 24·6	25·6 15·2
	,, ,,	,,		,,		,,	,,	ε Herculis	...	...	17	15	57·9	13·3	28·8	,,	,,
Mar. 3, 1st group	α Ursæ min.	W	7	37	47·0	23·3 12·3	14·8 25·8	63 Geminorum	...	...	7	39	35·0	49·0	3·4	21·6 11·2	16·5 27·0
	,, ,,	,,		,,		,,	,,	*f* Geminorum	...	53·4	7	51	7·2	21·1	35·0	10·5 22·3	27·6 15·9
	,, ,,	,,		,,		,,	,,	π Geminorum	38·6	54·6	8	0	10·2	26·1	42·2	13·5 22·0	25·0 16·2
	α Ursæ min.	E	8	14	15·0	24·0 10·3	14·2 27·9	6 Cancri	21·4	5·9	8	15	51·0	36·0	...	22·5 11·1	15·5 26·8
	,, ,,	,,		,,		,,	,,	ψ^2 Cancri	10·1	54·9	8	22	...	25·5	...	21·4 12·3	16·7 25·5
	,, ,,	,,		,,		,,	,,	χ Cancri	55·5	40·1	8	32	25·0	10·2	55·3	11·2 21·6	26·7 16·3
	,, ,,	,,		,,		,,	,,	ϕ^1 Cancri	23·8	8·2	8	38	53·2	38·5	23·2	21·7 11·3	16·2 26·6
	α Ursæ min.	W	8	53	42·0	14·9 20·2	23·2 17·9	ι Cancri	46·4	2·1	8	59	17·2	32·3	47·4	14·9 19·3	23·1 18·8
	,, ,,	,,		,,		,,	,,	10 Ursæ maj.	51·0	9·3	9	14	27·2	45·1	3·1	20·1 15·2	18·2 23·0
Mar. 3, 2nd group	α Ursæ min.	W	11	7	23·0	16·3 21·1	22·3 17·6	ψ Ursæ maj.	40·4	59·4	11	24	18·3	37·1	56·0	21·8 15·7	16·9 23·0
	,, ,,	,,		,,		,,	,,	ξ Ursæ maj.	27·8	43·5	11	32	59·7	15·0	30·7	16·2 20·4	22·5 18·1
	α Ursæ min.	E	11	41	33·0	23·0 16·2	15·6 22·5	58 Ursæ maj.	39·8	21·2	11	45	2·5	44·4	26·0	16·2 22·3	22·5 16·4
	,, ,,	,,		,,		,,	,,	61 Ursæ maj.	38·9	22·2	11	55	...	50·0	33·9	21·0 16·0	17·7 22·8
	α Ursæ min.	E	12	1	14·0	15·4 22·3	23·2 16·5	B.A.C. 4005	35·2	21·0	12	4	7·5	54·3	40·5	21·0 15·8	17·8 23·0
	,, ,,	,,		,,		,,	,,	1 Comæ	49·8	35·1	12	15	20·9	6·5	52·4	16·2 20·9	22·6 17·9
	α Ursæ min.	W	12	22	27·0	15·4 20·9	23·3 18·0	2 Canum ven.	6·1	24·4	12	30	42·0	59·3	17·1	20·8 15·4	18·1 23·5
	,, ,,	,,		,,		,,	,,	8 Canum ven.	4·5	22·8	12	48	40·7	58·3	16·2	20·3 15·2	18·5 23·6

Observations with Dr. Löw's transit instrument :—

OBSERVER, DR. LÖW ; CHRONOMETER NIEBERG.

Date, 1875	Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of transit over wire VI.			Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.				E	W
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Mar. 3, 1st group	63 Geminorum	E	39·8*	26·7	...	13·7	...	0·6	...	47·9	...	34·9	21·8	10	24	0·74	−16·9	−46·1
																	+17·8	+47·1
	f Geminorum	„	32·8†	20·4	...	7·9	...	55·2	...	42·7	...	29·9	17·5	10	35	55·24	...	...
	λ Ursæ min. S.P.	„	...	...	...	25·0	58·5	...	...	...	...	...	...	10	52	8·74	+18·0	+47·3
																	−15·9	−45·2
	„ „	W	...	...	...	18·0	46·5	...	...	...	...	...	...		51	35·26	+11·4	+40·7
																	−22·7	−51·8
	ψ^2 Cancri	„	51·6	...	...	18·4	...	31·7	...	45·1	...	58·7	12·0	11	6	31·81	−23·9	−53·2
																	+10·7	+39·9
	χ Cancri	„	22·2	36·1	...	49·5	...	3·1	...	16·3	...	30·2	43·9	11	16	3·07	...	...
	ϕ^1 Cancri	„	44·4	58·0	...	12·0	...	25·3	...	39·2	...	52·9	6·7	11	22	25·53	+10·9	+40·2
																	−23·0	−52·3
	39 Cancri	E	3·9	51·2	...	38·3	...	25·4	...	12·6	...	59·8	46·7	11	36	25·39	+16·4	+45·8
																	−16·9	−46·4
	10 Ursæ maj.	„	48·0	31·2	...	...	10·3	58·9	48·3	...	37·2	26·6	10·2	11	55	59·03	−24·2	−53·8
																	+9·1	+38·4

* 49·8 in original. † Uncertainty of $\frac{1}{2}^s$; rejected.

OBSERVER, MR. GILL ; CHRONOMETER 43.

Date, 1875	Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of transit over wire VI.			Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.				E	W
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Mar. 3	α Lyncis	W	7·4	22·2	...	37·0	...	51·9	...	6·3	...	21·1	36·0	9	33	51·73	+8·5	+38·2
																	−26·8	−56·5
	10 Leonis min.	„	14·1	29·2	...	44·2	...	59·4	...	14·5	...	29·6	45·0	9	46	59·46	−55·0	−25·1
																	+37·0	+7·0
	f Leonis	„	56·8	10·9	...	24·9	...	39·0	...	52·9	...	6·9	20·9	9	56‡	38·93	+7·5	+37·3
																	−26·0	−55·8
	μ Leonis	„	24·0	37·4	...	50·9	...	4·5	...	17·9	...	31·5	45·0	10	6	4·48	−56·2	−26·4
																	+37·6	+7·9
	Piazzi IX. 230	E	54·2	41·0	...	27·9	...	15·0	...	2·0	...	49·0	...	10	16	14·94	−50·1	−20·3
																	+43·1	+13·4
	Piazzi IX. 254	„	39·5	23·4	...	7·2	...	51·3	...	35·2	...	19·0	2·9	10	23	51·18	+14·3	+44·0
																	−20·1	−50·0
	Camelop. 30 H.	„	...	...	...	...	...	...	8·0	35·0	0·0	52·0	9·5	10	36	15·79	...	...
	„ „	W	...	...	...	...	...	...	...	1·7	...	45·0	27·5			21·13	...	...
	33 Leonis min.	„	...	42·2	...	56·4	...	11·1	...	25·4	...	39·9	54·4	10	45	11·06	+6·5	+36·4
																	−27·5	−57·5

‡ 51^m in original.

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, DR. LÖW; CHRONOMETER NIEBERG (*continued*).

Date, 1875	Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of transit over wire VI.			Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.				E p.	W p.
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.		
March 3, 2nd group	ψ Ursæ maj.	W	...	...	...	27·5	...	44·7	56·3	...	7·4	18·5	36·1	14	5	44·67	+17·1	+46·9
																	−15·3	−45·0
																	−15·3	−45·1
																	+17·5	+47·3
	ξ Ursæ maj.	„	53·2	7·3	...	21·4	...	35·5	...	49·9	...	4·2	18·6	14	14	35·76	...	...
	58 Ursæ maj.	E	37·3	20·7	...	3·9	...	47·0	...	30·2	...	13·7	...	14	26	47·07	−10·7	−40·3
																	+21·1	+51·1
	61 Ursæ maj.	„	12·1	57·2	...	42·9	...	28·1	...	13·7	...	58·7	44·2	14	37	28·10	+20·9	+50·7
																	−12·8	−42·6
	1 Comæ	„	56·1	43·1	...	30·0	...	16·3	...	3·8	...	50·1	37·4	14	58	16·66	−11·8	−41·8
																	+20·1	+50·1
	2 Canum ven.	W	...	...	26·2	...	36·6	47·4	58·1	...	8·8	19·3	35·3	15	12	47·36	−16·4	−46·4
																	+16·0	−46·1
																	+15·1	+45·1
																	−18·1	−48·0
	8 Canum ven.*	„	52·3	8·7	19·6	...	30·3	41·0	52·0	...	2·7	13·2	29·9	15	30	41·09	...	...
	Cephei 43 H., S.P.	„	...	...	...	...	...	24·5	40·0	49·5	...	...	...	15	54	24·61	−15·6	−45·6
																	+15·3	+45·9
	„ „	E	...	...	..	...	...	...	15·5	7·0	0·5	44·8	...			31·62	−13·8	−43·8
																	+19·1	+49·2

* This star is noted 'E' in original.

Observations with the Troughton and Simms' altazimuth :—

OBSERVER, MR. GILL; CHRONOMETER 43.

Date, 1875	Pole star	Position of circle	Chronometer time of Pole star on wire III.			Level readings		Time star	Chronometer times of transit over the wires						Level readings	
									I.	II.	III.			IV.	V.	
			h.	m.	s.	E p.	W p.		s.	s.	h.	m.	s.	s.	s.	E p.	W p.
Mar. 10, 1st group	α Ursæ min.	E	7	44	6·0	18·3	20·2	*f* Geminorum	24·0	...	7	50	55·6	42·0	28·2	18·9	19·6
						24·3	14·0									24·5	14·0
	„ „	„		„		„	„	π Geminorum	...	14·6	7	59	58·6	42·9	26·8	20·2	18·1
																26·2	12·2
	α Ursæ min.	W	8	10	52·0	23·4	14·9	6 Cancri†	8·0	23·5	8	15	38·8	53·4	...	19·3	19·0
						18·0	20·3									23·8	14·8
Mar. 10, 2nd group	α Ursæ min.	W	9	54	16·0	24·2	14·1	μ Leonis	52·9	8·0	10	5	22·9	37·5	52·0	19·4	19·0
						20·3	18·0									24·3	14·1
	α Ursæ min.	E	10	12	50·0	19·4	19·0	Piazzi IX. 230	44·8	30·0	10	15	15·9	1·8	47·4	24·8	13·8
						25·0	13·6									20·0	18·4
	„ „	„		„		„	„	Piazzi IX. 254	21·8	...	10	24	46·1	28·4	11·0	25·0	13·5
																20·0	18·6
	α Ursæ min.	W	10	42	33·0	20·9	17·7	μ Ursæ maj.	35·6	53·8	10	36	11·5	29·3	47·1	16·3	22·1
						16·0	22·4									21·3	17·1
	„ „	„		„		„	„	33 Leonis min.	34·1	50·4	10	45	...	22·0	38·0	21·6	17·0
																16·4	22·0
	α Ursæ min.	E	10	53	41·0	21·1	17·6	42 Leonis min.	38·4	...	10	59	7·2	51·4	36·0	16·0	22·7
						15·8	22·7									21·4	17·3
	„ „	„		„		„	„	46 Leonis min.	22·3	5·9	11	6	49·7	33·4	17·3	21·7	16·9
																16·3	22·1
	α Ursæ min.	W	11	14	9·0	20·8	17·8	ψ Ursæ maj.	23·8	42·9	11	24	2·0	20·5	39·4	15·8	22·8
						15·5	23·1									20·3	18·3
	„ „	„		„		„	„	ξ Ursæ maj.	14·4	30·5	11	31	46·3	1·5	...	20·5	18·0
																15·5	23·0

† Haze; observation unsatisfactory.

OBSERVATIONS WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH. OBSERVER, MR. GILL;
CHRONOMETER 43 (*continued*).

Date, 1875	Pole star	Position of circle	Chronometer time of Pole star on wire III.			Level readings E	Level readings W	Time star	Chronometer times of transit over the wires I.	II.	III.			IV.	V.	Level readings E	Level readings W
			h.	m.	s.	p.	p.		s.	s.	h.	m.	s.	s.	s.	p.	p.
Mar. 11, 1st group	α Ursæ min.	W	7	14	19·0	15·3 20·0	23·0 18·4	ζ Geminorum	...	...	7	15	...	50·0	4·3	20·5 15·7	17·9 22·9
	" "	"		"		"	"	63 Aurigæ	48·0	5·8	7	24	22·8	39·9	57·2	16·3 21·4	22·1 17·1
	α Ursæ min.	E	7	32	53·0	16·7 21·3	21·7 17·0	65 Aurigæ	12·1	54·0	7	34	38·5	...	...	21·1 15·5	17·3 22·8
	" "	"		"		"	"	63 Geminorum	49·3	34·8	7	39	20·4	6·0	52·0	15·5 20·8	23·0 17·6
	α Ursæ min.	W	7	47	8·0	16·0 21·4	22·4 17·0	f Geminorum	24·0	38·2	7	50	52·1	6·0	20·2	21·3 15·8	17·0 22·7
	" "	"		"		"	"	π Geminorum	23·0	39·6	7	59	55·3	...	27·2	20·1 16·9	18·3 21·7
	α Ursæ min.	E	8	9	0·0	16·3 22·0	22·0 16·4	6 Cancri	7·3	52·0	8	15	36·8	21·9	7·0	22·0 16·0	16·6 22·5
	" "	"		"		"	"	ψ^2 Cancri	59·0	40·5	8	22	26·0	...	...	16·2 22·1	22·3 16·3
	α Ursæ min.	W	8	30	32·0	16·0 24·0	22·5 18·0	χ Cancri	...	...	8	32	10·9	25·7	40·5	20·0 16·2	18·4 22·3
	" "	"		"		"	"	ϕ^1 Cancri	8·4	24·0	8	38	39·1	53·8	9·0	16·2 20·8	22·4 17·8
Mar. 11, 2nd group	α Ursæ min.	E	10	53	50·0	17·0 23·1	21·6 15·6	42 Leonis min.	37·0	21·0	10	59	5·6	50·2	34·5	23·0 18·0	15·8 20·8
	" "	"		"		"	"	46 Leonis min.	21·0	4·4	11	6*	48·1	32·0	16·0	17·3 23·3	21·3 15·5
	α Ursæ min.	W	11	14	43·0	22·8 16·6	16·0 22·2	ψ Ursæ maj.	22·3	41·5	11	24	0·4	19·0	37·6	17·2 23·5	21·7 15·2
	" "	"		"		"	"	ξ Ursæ maj.	13·0	28·9	11	31	44·8	0·1	16·0	22·4 17·8	16·3 21·2
	α Ursæ min.	W	11	37	40·0	17·5 23·0	21·3 15·8	58 Ursæ maj.	12·3	31·0	11	44	49·5	7·8	26·1	23·0 17·6	16·0 21·3
	" "	"		"		"	"	61 Ursæ maj.	18·9	35·6	11	54	51·9	7·5	23·9	17·3 22·5	21·6 16·3
	α Ursæ min.	E	12	4	13·0	24·0 18·3	14·9 20·4	1 Comæ	36·9	22·1	12	15	7·8	53·4	39·0	18·2 24·6	20·9 14·5
Mar. 11, 3rd group	α Ursæ min.	E	15	39	24·0	18·6 24·0	20·8 15·5	β Coronæ	27·0	11·4	15	42	56·2	41·1	25·9	24·6 19·8	14·9 19·8
	α Ursæ min.	W	15	54	27·0	24·0 19·0	15·5 20·5	δ Coronæ	19·5	34·8	16	4	49·5	4·3	19·0	23·7 19·0	16·0 20·5
	" "	"		"		"	"	λ Coronæ	14·4	31·9	16	11	48·8	5·7	22·5	24·0 19·4	15·4 20·1
	α Ursæ min.	E	16	17	25·0	24·3 19·2	15·1 20·2	τ Coronæ	36·3	19·3	16	24*	3·0	46·5	30·0	19·5 25·1	20·1 14·5
	" "	"		"		"	"	υ Coronæ	32·4	17·0	16	32	1·9	46·8	31·8	25·0 20·0	14·8 19·8
Mar. 12, 1st group	α Ursæ min.	W	6	59	23·0	19·7 16·0	18·5 22·3	θ Geminorum	30·2	...	7	5	2·8	18·4	34·5	17·5 20·0	20·8 18·3
	α Ursæ min.	E	7	12	37·0	16·1 21·1	22·0 17·0	ζ Geminorum	3·9	49·3	7	15*	35·1	21·1	6·9	19·5 16·4	18·3 21·8
	" "	"		"		"	"	63 Aurigæ	56·9	39·2	7	24	21·9	4·8	47·5	16·4 21·6	21·7 16·5
	α Ursæ min.	W	7	32	2·0	22·3 14·5	16·0 23·8	65 Aurigæ	2·6	19·5	7	34	36·3	52·8	9·4	15·2 20·9	23·0 17·4
	" "	"		"		"	"	63 Geminorum	...	3·3	7	39	...	32·2	46·5	19·1 16·0	19·1 22·3
	α Ursæ min.	E	7	48	30·0	21·3 16·5	16·7 21·8	f Geminorum	19·5	5·1	7	50	51·2	37·6	23·7	14·8 22·1	23·5 16·0
	" "	"		"		"	"	π Geminorum	26·8	10·0	7	59	54·1	38·6	22·8	17·5 21·1	20·3 17·2
	α Ursæ min.	W	8	9	40·0	21·3 15·2	17·0 23·1	6 Cancri	4·1	19·7	8	15	34·9	49·4	4·6	15·5 21·1	22·8 17·1
	" "	"		"		"	"	ψ^2 Cancri	...	8·9	8	22	23·8	38·4	53·0	15·4 22·1	21·8 16·0

* Minute supplied.

OBSERVATIONS WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH. OBSERVER, MR. GILL; CHRONOMETER 43 (*continued*).

Date, 1875	Pole star	Position of circle	Chronometer time of Pole star on wire III.	Level readings	Time star	Chronometer times of transit over the wires					Level readings
						I.	II.	III.	IV.	V.	
			h. m. s.	E p. W p.		s.	s.	h. m. s.	s.	s.	E p. W p.
Mar. 12, 1st group (*cont.*)	*a* Ursæ min.	E	8 30 52·0	16·0 21·1 22·3 15·9	39 Cancri	18·3	3·8	8 51 49·4	35·3	21·1	17·6 20·6 22·0 16·4
	" "	"	"	" "	ι Cancri	31·9	16·0	8 59 0·8	45·9	30·6	22·6 15·6 16·8 21·5
Mar. 12, 2nd group	*a* Ursæ min.	E	11 12 23·0	18·0 20·2 22·7 15·5	ψ Ursæ maj.	38·4	19·0	11 19 0·3	41·8	...	23·2 15·1 17·6 20·9
	" "	"	"	" "	ξ Ursæ maj.	15·3	59·3	11 31 43·5	28·2	12·4	18·2 20·1 23·5 14·8
	a Ursæ min.	W	11 38 38·0	23·4 14·9 17·3 21·1	61 Ursæ maj.	17·3	33·4	11 55 50·0	6·1	22·1	23·1 15·3 17·3 21·2
	a Ursæ min.	E	12 5 44·5	17·9 20·6 23·3 15·1	1 Comæ	35·4	20·8	12 15 6·0	51·9	37·6	23·9 14·9 18·0 20·9
Mar. 13, 1st group	*a* Ursæ min.	E	8 7 29·0	23·3 14·9 16·8 21·5	6 Cancri	3·5	48·2	8 15 33·1	19·1	3·1	21·1 17·2 18·2 22·3
	" "	"	"	" "	ψ^2 Cancri	52·2	37·0	8 21 57·2	7·7	53·0	17·7 20·7 23·4 15·2
	a Ursæ min.	W	8 31 6·0	20·2 18·3 18·4 20·0	39 Cancri	18·4	32·9	8 51 ...	1·0	15·3	21·7 17·0 20·0 18·7
	" "	"	"	" "	ι Cancri	27·8	43·4	8 58 58·8	13·8	28·9	20·3 18·5 21·0 17·7
Mar. 13, 2nd group	*a* Ursæ min.	E	10 47 43·0	19·6 20·3 25·2 14·6	46 Leonis min.	18·1	1·4*	11 6 45·3	29·4	13·0	24·4 15·3 20·3 19·5
	a Ursæ min.	W	11 4 14·0	20·1 19·8 23·3 16·4	ψ Ursæ maj.	19·0	38·4	11 23 57·1	15·8	34·8	22·9 16·9 21·0 18·8
	" "	"	"	" "	ξ Ursæ maj.	9·5	25·8	11 31 41·6	57·0	12·5	23·9 15·7 20·3 19·5
	a Ursæ min.	W	11 41 11·0	23·7 16·0 20·6 18·9	58 Ursæ maj.	7·5	26·1	11 44 44·7	2·8	21·2	21·5 18·0 23·4 16·1
	" "	"	"	" "	61 Ursæ maj.	15·1	31·8	11 54 48·0	4·0	20·3	21·1 18·4 23·9 15·9
	a Ursæ min.	E	12 1 41·5	22·5 17·1 22·8 16·8	B.A.C. 4005	18·1	...	12 4 50·4	36·7	23·1	22·0 17·4 24·2 16·3
	" "	"	"	" "	1 Comæ	32·7	17·6	12 15 ...	49·3	34·9	23·9 15·8 21·4 18·2
Mar. 13, 3rd group	*a* Ursæ min.	E	16 32 11·0	20·1 19·2 23·3 15·0	*a* Scorpii	29·0	13·8	16 46 59·3	44·5	29·5	... ...
	a Ursæ min.	W	16 50 57·0	24·8 15·0 20·0 19·7	ζ Herculis	3·6	19·8	16 56 35·3	50·4	6·2	20·3 19·3 25·1 14·7
	a Ursæ min.	E	17 4 0·0	20·7 19·0 25·2 14·5	ε Herculis	6·8	50·9	17 15 35·6	20·1	4·6	21·1 18·7 25·0 15·0
Mar. 14	*a* Ursæ min.	E	10 38 32·0	19·8 18·4 22·2 16·0	33 Leonis min.	31·5	15·1	10 44 59·5	43·9	28·0	25·1 13·1 18·4 19·8
	a Ursæ min.	W	10 54 23·0	19·0 19·1 23·9 14·2	42 Leonis min.	28·0	44·0	10 58 59·4	14·9	30·2	24·1 14·0 18·3 19·7
	" "	"	"	" "	46 Leonis min.	9·1	25·8	11 6 41·9	58·0	14·1	19·0 19·1 24·0 14·0
	a Ursæ min.	E	11 14 1·0	19·5 18·4 24·1 13·8	ψ Ursæ maj.	33·6	14·0	11 23 55·5	36·9	18·2	24·3 13·8 19·8 18·2
	" "	"	"	" "	ξ Ursæ maj.	11·3	55·4	11 31 39·6	24·0	8·4	" "
	a Ursæ min.	W	11 36 25·5	18·8 19·3 24·8 13·4	58 Ursæ maj.	7·0	26·0	11 44 44·4	2·5	21·0	23·5 14·6 18·9 19·4
	" "	"	"	" "	61 Ursæ maj.	13·5	30·1	11 54 46·4	2·4	...	18·8 19·3 25·0 13·1
Mar. 15	*a* Ursæ min.	E	9 52 33·0	23·2 14·7 19·1 18·9	*f* Leonis	...	...	9 56 11·3	...	40·3	17·5 20·3 23·1 15·0
	" "	"	"	" "	μ Leonis	43·1	27·9	10 5 ...	58·2	43·4	22·2 15·6 18·1 19·8
	a Ursæ min.	W	10 12 27·0	23·1 14·8 19·2 19·0	Piazzi IX. 230	...	50·9	10 15 4·8	19·2	33·4	17·4 20·3 23·8 14·3
	" "	"	"	" "	μ Ursæ maj.	32·0	50·3	10 36 8·2	25·9	43·9	19·1 19·0 23·3 14·8

* 41^{s}·4 in original.

From the foregoing observations we obtain :—

With the Troughton and Simms' Altazimuth.

Observer, Mr. Gill; Chronometer 43.

Date	Epoch by chronometer h. m.	Assumed chronometer rate s.	c. s.
1875, Feb. 19, 1st group	7 34	+0·157 per hour	−1·609
„ „ 2nd group	11 18	„ „	−1·740
„ Feb. 20, 1st group	7 36	+0·104 „	−1·665
„ „ 2nd group	11 8	„	−1·513
„ Feb. 23, 1st group	7 48	„ „	−1·265
„ „ 2nd group	11 21	„ „	−1 279
„ Feb. 25	8 0	+0·065 „	−1·289
„ Feb. 27	10 59	„ „	−1·520
„ Feb. 28, 1st group	10 46	„ „	−0·202*
„ „ 2nd group	17 4	„ „	−0·329

* On this day the object-glass was screwed up.

Date, 1875	Star	Position of circle	C	Concluded chronometer time of transit over wire III. h. m. s.	R.A. of star, including daily aberration h. m. s.	Rate of chronometer to epoch s.	t − m m. s.	Cc s.	Chronometer correction h. m. s.
Feb. 19, 1st group	*a* Canis maj.	W	−1·942	6 55 38·70	6 39 39·26	+0·10	−4 48·31	+3·12	−0 20 44·53
	63 Aurigæ	„	−1·078	7 25 2·53	7 3 4·88	+0·02	+1 11·12	+1·73	44·78
	65 Aurigæ	E	+1·104	7 35 14·11	7 13 42·95	0·00	+0 48·25	−1·77	44·68
	f Geminorum	W	−1·333	7 51 33·00	7 32 16·72	−0·05	−1 30·77	+2·14	44·96
	π Geminorum	„	−1·141	8 0 35·44	7 39 28·31	−0·07	+0 20·41	+1·84	44·95
Feb. 19, 2nd group	33 Leonis min.	W	−1·148	10 45 43·52	10 24 47·42	+0·08	+0 9·97	+2·00	−0 20 44·05
	42 Leonis min.	E	+1·168	10 59 39·47	10 38 56·60	+0·05	+0 0·65	−2·03	44·20
	46 Leonis min.	„	+1·127	11 7 22·28	10 46 21·06	+0·03	+0 18·67	−1·96	44·48
	ψ Ursæ maj.	W	−1·015	11 24 38·97	11 2 40·22	−0·02	+1 12·81	+1·77	44·19
	ξ Ursæ maj.	„	−1·157	11 32 23·41	11 11 32·52	−0·04	+0 4·21	+2·01	44·71
	61 Ursæ maj.	E	+1·126	11 55 26·14	11 34 29·90	−0·10	+0 14·01	−1·96	44·29
Feb. 20, 1st group	*θ* Geminorum	E	+1·137	7 5 38·10	6 44 34·25	+0·05	+0 23·05	−1·89	−0 20 42·64
	63 Aurigæ	W	−1·078	7 25 0·43	7 3 4·87	+0·02	+1 11·07	+1·80	42·67
	65 Aurigæ	„	−1·104	7 35 15·61	7 13 42·94	0·00	+0 47·81	+1·84	43·02
	63 Geminorum	„	−1·284	7 39 57·70	7 20 20·46	−0·01	−1 7·33	+2·14	42·44
	f Geminorum	E	+1·333	7 51 26·06	7 32 16·71	−0·03	−1 31·06	−2·22	42·66
	π Geminorum	„	+1·141	8 0 29·14	7 39 28·30	−0·04	+0 19·98	−1·90	42·80
Feb. 20, 2nd group	Piazzi IX. 254	E	+1·057	10 25 16·46	10 3 28·76	+0·07	+1 6·91	−1·60	−0 20 42·32
	μ Ursæ maj.	„	+1·047	10 36 49·26	10 14 54·93	+0·05	+1 13·47	−1·58	42·39
	33 Leonis min.	„	+1·148	10 45 38·88	10 24 47·43	+0·04	+0 10·83	−1·74	42·32
	42 Leonis min.	W	−1·168	10 59 41·25	10 38 56·61	+0·02	+0 0·68	+1·77	42·17
	46 Leonis min.	„	−1·127	11 7 23·98	10 46 21·07	0·00	+0 18·91	+1·71	42·29
	ξ Ursæ maj.	E	+1·157	11 32 17·69	11 11 32·54	−0·04	+0 4·57	−1·75	42·37
	58 Ursæ maj.	W	−1·029	11 45 24·90	11 23 47·32	−0·06	+0 53·75	+1·56	42·33
	61 Ursæ maj.	„	−1·126	11 55 28·08	11 34 29·92	−0·08	+0 13·93	+1·70	42·61
Feb. 23, 1st group	*ε* Geminorum	E	+1·240	6 56 8·39	6 36 15·55	+0·09	−0 42·41	−1·57	−0 20 36·73
	θ Geminorum	„	+1·137	7 5 33·98	6 44 34·21	+0·07	+0 23·50	−1·44	37·64

OBSERVATIONS WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH. OBSERVER, MR. GILL; CHRONOMETER 43 (*continued*).

Date, 1875	Star	Position of circle	C	Concluded chronometer time of transit over wire III.			R.A. of star, including daily aberration			Rate of chronometer to epoch	t − m		Cc	Chronometer correction		
				h.	m.	s.	h.	m.	s.	s.	m.	s.	s.	h.	m.	s.
Feb. 23, 1st group (*cont.*)	ζ Geminorum	W	−1·296	7	16	8·12	6	56	42·85	+0·06	−1	13·05	+1·64	−0	20	36·62
	63 Aurigæ	,,	−1·078	7	24	55·35	7	3	4·82	+0·04	+1	11·35	+1·36			37·78
	63 Geminorum	E	+1·284	7	39	48·34	7	20	20·44	+0·01	−1	7·20	−1·62			36·71
	f Geminorum	W	−1·333	7	51	23·84	7	32	16·69	0·00	−1	30·97	+1·69			36·43
	6 Cancri	E	+1·205	8	16	4·35	7	55	51·88	−0·05	−0	22·76	−1·52			36·80
	ψ^2 Cancri	,,	+1·233	8	22	54·13	8	2	56·94	−0·06	−0	38·69	−1·56			37·50
	χ Cancri	W	−1·212	8	32	41·83	8	12	29·86	−0·08	−0	26·20	+1·53			36·72
	ϕ^1 Cancri	,,	−1·204	8	39	11·14	8	18	53·12	−0·09	−0	21·37	+1·52			37·96
Feb. 23, 2nd group	33 Leonis min.	E	+1·148	10	45	32·72	10	24	47·46	+0·06	+0	9·96	−1·47	−0	20	36·71
	42 Leonis min.	W	−1·168	10	59	35·77	10	38	56·64	+0·04	+0	0·82	+1·49			36·78
	46 Leonis min.	,,	−1·127	11	7	18·25	10	46	21·10	+0·02	+0	18·78	+1·44			36·91
	ψ Ursæ maj.	E	+1·015	11	24	28·41	11	2	40·28	−0·01	+1	12·29	−1·30			37·15
	ξ Ursæ maj.	,,	+1·157	11	32	12·57	11	11	32·57	−0·02	+0	4·77	−1·48			36·73
	58 Ursæ maj.	W	−1·029	11	45	18·98	11	23	47·37	−0·04	+0	53·30	+1·32			37·03
	61 Ursæ maj.	,,	−1·126	11	55	22·02	11	34	29·97	−0·06	+0	13·96	+1·44			36·71
Feb. 25	ζ Geminorum	W	−1·296	7	16	3·52	6	56	42·83	+0·05	−1	13·39	+1·67	−0	20	32·36
	63 Aurigæ	,,	−1·078	7	24	50·63	7	3	4·80	+0·04	+1	10·75	+1·39			33·65
	63 Geminorum	E	+1·284	7	39	44·00	7	20	20·42	+0·02	−1	7·67	−1·66			32·89
	f Geminorum	W	−1·333	7	51	19·46	7	32	16·67	+0·01	−1	31·45	+1·72			32·51
	6 Cancri	E	+1·205	8	15	59·89	7	55	51·87	−0·02	−0	22·87	−1·55			32·46
	ψ^2 Cancri	,,	+1·233	8	22	49·75	8	2	56·92	−0·02	−0	38·71	−1·59			33·15
	χ Cancri	W	−1·212	8	32	37·75	8	12	29·85	−0·03	−0	26·06	+1·56			32·43
	ϕ^1 Cancri	,,	−1·204	8	39	6·95	8	18	53·11	−0·04	−0	21·11	+1·55			33·44
Feb. 27	Piazzi IX. 230	E	+1·275	10	15	31·70	9	55	52·46	+0·05	−0	47·38	−1·94	−0	20	28·51
	Piazzi IX. 254	,,	+1·057	10	25	3·80	10	3	28·81	+0·04	+1	7·19	−1·61			29·37
	μ Ursæ maj.	W	−1·047	10	36	33·38	10	14	54·99	+0·02	+1	7·68	+1·59			29·10
	33 Leonis min.	,,	−1·148	10	45	28·15	10	24	47·49	+0·01	+0	9·91	+1·74			29·00
	ψ Ursæ maj.	,,	−1·015	11	24	30·03	11	2	40·35	−0·03	+1	19·48	+1·54			28·69
	ξ Ursæ maj.	,,	−1·157	11	32	8·26	11	11	32·64	−0·04	+0	5·03	+1·76			28·89
	61 Ursæ maj.	E	+1·126	11	55	10·98	11	34	30·02	−0·06	+0	13·77	−1·71			28·96
Feb. 28, 1st group	*f* Leonis	W	−1·177	9	56	38·31	9	36	15·42	+0·05	−0	4·11	+0·24	−0	20	26·71
	μ Leonis	,,	−1·224	10	5	40·02	9	45	40·94	+0·04	−0	27·97	+0·25			26·76
	Piazzi IX. 254	E	+1·057	10	25	2·32	10	3	28·81	+0·02	+1	6·67	−0·21			27·03
	μ Ursæ maj.	,,	+1·047	10	36	29·96	10	14	54·99	+0·01	+1	8·18	−0·21			26·99
	33 Leonis min.	,,	+1·148	10	45	24·38	10	24	47·50	0·00	+0	10·26	−0·23			26·85
	42 Leonis min.	W	−1·168	10	59	24·91	10	38	56·69	−0·01	+0	0·59	+0·24			27·40
	46 Leonis min.	,,	−1·127	11	7	7·22	10	46	21·15	−0·02	+0	18·67	+0·23			27·19
	ψ Ursæ maj.	E	+1·015	11	24	17·99	11	2	40·36	−0·04	+1	10·72	−0·21			27·16
	ξ Ursæ maj.	,,	+1·157	11	32	3·96	11	11	32·65	−0·05	+0	4·54	−0·23			27·05
Feb. 28, 2nd group	σ Herculis	E	+1·042	16	49	14·86	16	30	4·86	+0·02	−1	16·24	−0·34	−0	20	26·56
	ζ Herculis	,,	+1·162	16	56	57·57	16	36	34·82	+0·01	−0	3·51	−0·38			26·63
	κ Ophiuchi	W	−1·457	17	14	5·41	16	51	45·24	−0·01	+1	53·02	+0·48			26·68
	ε Herculis	,,	−1·170	17	15	57·96	16	55	30·64	−0·01	+0	0·45	+0·38			26·50

OBSERVATIONS WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH. OBSERVER, MR. GILL; CHRONOMETER 43 (*continued*).

Date	Epoch by chronometer h. m.	Assumed chronometer rate s.	c. s.
1875, Mar. 3, 1st group	8 24	+0·019 per hour	−0·148
„ „ 2nd group	12 2	„ „	+0·017

Date, 1875	Star	Position of circle	C	Concluded chronometer time of transit over wire III. h. m. s.	R.A. of star, including daily aberration h. m. s.	Rate of chronometer to epoch s.	t − m m. s.	Cc s.	Chronometer correction h. m. s.
Mar. 3, 1st group	63 Geminorum	W	−1·284	7 39 34·96	7 20 20·35	+0·01	−1 7·86	+0·19	−0 20 22·27
	f Geminorum	„	−1·333	7 51 7·28	7 32 16·61	+0·01	−1 31·82	+0·20	22·28
	π Geminorum	„	−1·141	8 0 10·50	7 39 28·20	+0·01	+0 19·77	+0·17	22·35
	6 Cancri	E	+1·205	8 15 50·90	7 55 51·81	0·00	−0 22·99	−0·18	22·26
	ψ^2 Cancri	„	+1·233	8 22 40·13	8 2 56·88	0·00	−0 38·81	−0·18	22·24
	χ Cancri	„	+1·212	8 32 25·07	8 12 29·81	0·00	−0 26·75	−0·18	22·19
	ϕ^1 Cancri	„	+1·204	8 38 53·23	8 18 53·07	0·00	−0 21·88	−0·18	22·22
	ι Cancri	W	−1·193	8 59 17·23	8 39 9·53	−0·01	−0 14·45	+0·18	21·98
	10 Ursæ maj.	„	−1·047	9 14 27·32	8 52 33·29	−0·02	+1 31·65	+0·15	22·25
Mar. 3, 2nd group	ψ Ursæ maj.	W	−1·015	11 24 18·43	11 2 40·39	+0·01	+1 15·85	−0·02	−0 20 22·20
	ξ Ursæ maj.	„	−1·157	11 31 59·50	11 11 32·68	+0·01	+0 4·53	−0·02	22·30
	58 Ursæ maj.	E	+1·029	11 45 2·60	11 23 47·50	+0·01	+0 52·95	+0·02	22·12
	61 Ursæ maj.	„	+1·126	11 55 6·05	11 34 30·09	0·00	+0 13·66	+0·02	22·28
	B.A.C. 4005	„	+1·408	12 4 7·56	11 44 32·00	0·00	−0 46·70	+0·02	22·24
	1 Comæ	„	+1·273	12 15 20·80	11 55 21·85	0·00	−0 23·17	+0·02	22·10
	2 Canum ven.	W	−1·055	12 30 41·96	12 9 53·84	−0·01	+0 26·07	−0·02	22·08
	8 Canum ven.	„	−1·048	12 48 40·68	12 27 50·47	−0·01	+0 28·08	−0·02	22·16

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT.

OBSERVER, DR. LÖW; CHRONOMETER NIEBERG (MEAN TIME).

	h. m. s.
Epoch by chronometer . .	11 11 0·00
Assumed chronometer rate . .	+9ˢ·946 per hour
Collimation by reversing on λ Ursæ minoris	−0ˢ·130 Circle W
Azimuth by combining λ Ursæ minoris with all the time stars .	−0ˢ·342

LEVELLINGS.

E p.	W p.
+0·48	−5·60
+1·05	−6·62
−0·28	−6·25
	−7·62

Allowing for inequality of pivots

	p.	s.
E	= +0·27	= +0·030
W	= −6·37	= −0·707

Date, 1875	Star	Position of circle	Concluded chronometer time of transit over wire VI. h. m. s.	Rate of chronometer to epoch s.	Sum of instrumental corrections s.	R.A. of star, including daily aberration h. m. s.	Chronometer correction h. m. s.
Mar. 3, 1st group	63 Geminorum	E	10 24 0·74	−7·79	+ 0·11	7 20 20·35	−3 3 32·71
	f Geminorum	„	10 35 55·24	−5·81	+ 0·09	7 32 16·61	32·91
	λ Ursæ min. S.P.	„	10 52 8·74	−3·13	−23·50	19 48 8·92	[33·18]
	„ „	W	51 35·26	−3·22	+ 10·06	„	
	ψ^2 Cancri	„	11 6 31·81	−0·74	− 0·95	8 2 56·88	33·24
	χ Cancri	„	11 16 3·07	+0·84	− 0·97	8 12 29·81	33·13
	ϕ^1 Cancri	„	11 22 25·53	+1·90	− 0·97	8 18 53·07	33·39
	39 Cancri	E	11 36 25·39	+4·22	+ 0·10	8 32 56·34	33·37
	10 Ursæ maj.	„	11 55 59·03	+7·46	+ 0·31	8 52 33·29	33·51

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, MR. GILL; CHRONOMETER 43 (*continued*).

	h.	m.	
Epoch by chronometer .	10	7	
Assumed chronometer rate	+0^{s}·019		
Collimation by reversing on Camelop. 30 H. . .	−0^{s}·114		Circle W
Azimuth by Camelop. 30 H. and time stars. . .	−0^{s}·329		

LEVELLINGS.

E	W
p.	p.
−3·48	− 9·15
−2·95	− 9·02
	− 9·25
	− 9·28
	−10·52

Allowing for inequality of pivots

p. s.

E = −3·37 = −0·374

W = −9·29 = −1·031

Date, 1875	Star	Position of circle	Concluded chronometer time of transit over wire VI.	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
			h. m. s.	s.	h. m. s.	h. m. s.
March 3	α Lyncis	W	9 33 51·73	−1·37	9 13 28·18	−0 20 22·18
	10 Leonis min.	,,	9 46 59 46	−1·38	9 26 35·78	22·30
	f Leonis	,,	9 56 38·93	−1·33	9 36 15·42	22·18
	μ Leonis	,,	10 6 4·48	−1·31	9 45 40·94	22·23
	Piazzi IX. 230	E	10 16 14·94	−0·33	9 55 52·46	22·15
	Piazzi IX. 254	,,	10 23 51·18	−0·26	10 3 28·82	22·10
	Camelop. 30 H.	,,	10 36 15·79	+1·21	10 15 54·81	[22·19]
	,, ,,	W	21·13	−4·13	,,	
	33 Leonis min.	,,	10 45 11·06	−1·36	10 24 47·51	22·19

OBSERVER, DR. LÖW; CHRONOMETER NIEBERG (MEAN TIME).

	h.	m.	s.	
Epoch by chronometer . .	14	44	0·00	
Assumed chronometer rate .	+9^{s}·946			per hour
Collimation by reversing on Cephei 43 H., S.P. . .	−0^{s}·178			Circle W
Azimuth by Cephei 43 H., S.P., and time stars . . .	−0^{s}·067			

LEVELLINGS.

E	W
p.	p.
+5·30	+0·92
+4·05	+1·10
+4·15	−0·18
+2·68	−1·48
	0·00

p. s.

E = +3·89 = +0·432

W = +0·22 = +0·024

Date, 1875	Star	Position of circle	Concluded chronometer time of transit over wire VI.	Rate of chronometer to epoch	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
			h. m. s.	s.	s.	h. m. s.	h. m. s.
March 3, 2nd group	ψ Ursæ maj.	W	14 5 44·67	− 6·34	−0·20	11 2 40·39	−3 2 57·74
	ξ Ursæ maj.	,,	14 14 35·76	− 4·87	−0·18	11 11 32·68	58·03
	58 Ursæ maj.	E	14 26 47·07	− 2·86	+0·85	11 23 47·50	57·56
	61 Ursæ maj.	,,	14 37 28·10	− 1·08	+0·76	11 34 30·09	57·69
	1 Comæ	,,	14 58 16·66	+ 2·37	+0·64	11 55 21·85	57·82
	2 Canum ven.	W	15 12 47·36	+ 4·77	−0·19	12 9 53·84	58·10
	8 Canum ven.	,,	15 30 41·09	+ 7·74	−0·19	12 27 50·47	58·17
	Cephei 43 H., S.P.	,,	15 54 24·61	+11·67	+1·40	0 51 39·81	[57·87]
	,, ,,	E	31·62	+11·69	−5·63	,,	

Observations with the Troughton and Simms' Altazimuth.

Observer, Mr. Gill; Chronometer 43.

Date	Epoch by chronometer h. m.	Assumed chronometer rate s.	c. s.
1875, Mar. 10, 1st group	8 2	+0·064 per hour	+0·324
„ „ 2nd group	10 48	„ „	+0·275
„ Mar. 11, 1st group	7 57	+0·038 „	+0·231
„ „ 2nd group	11 34	„ „	+0·218
„ „ 3rd group	16 11	„ „	+0·206
„ Mar. 12, 1st group	7 56	+0·056 „	+0·159
„ „ 2nd group	11 46	„ „	+0·180
„ Mar. 13, 1st group	8 37	+0·022 „	+0·110
„ „ 2nd group	11 43	„ „	+0·102
„ „ 3rd group	16 59	„ „	+0·085
„ Mar. 14	11 21	+0·063 „	+0·089
„ Mar. 15	10 13	+0·063 „	+0·131

Date, 1875	Star	Position of circle	C	Concluded chronometer time of transit over wire III.	R.A. of star, including daily aberration	Rate of chronometer to epoch	t − m	Cc	Chronometer correction
				h. m. s.	h. m. s.	s.	m. s.	s.	h. m. s.
Mar. 10, 1st group	*f* Geminorum	E	+1·333	7 50 55·76	7 32 16·52	+0·01	−1 30·68	+0·43	−0 20 9·48
	π Geminorum	„	+1·141	7 59 58·60	7 39 28·10	0·00	+0 20·83	+0·37	9·30
	6 Cancri	W	−1·205	8 15 38·64	7 55 51·72	−0·01	−0 22·08	−0·39	9·40
Mar. 10, 2nd group	*μ* Leonis	W	−1·224	10 5 22·81	9 45 40·93	+0·04	−0 26·74	−0·34	−0 20 8·92
	Piazzi IX. 230	E	+1·275	10 15 15·84	9 55 52·46	+0·03	−0 46·03	+0·35	9·03
	Piazzi IX. 254	„	+1·057	10 24 45·99	10 3 28·82	+0·02	+1 7·68	+0·29	9·18
	μ Ursæ maj.	W	−1·047	10 36 11·64	10 14 55·01	+0·01	+1 7·65	−0·29	9·16
	33 Leonis min.	„	−1·148	10 45 6·32	10 27 57·54	0·00	+0 9·93	−0·32	9·27
	42 Leonis min.	E	+1·168	10 59 6·94	10 38 56·74	−0·01	+0 0·51	+0·32	9·38
	46 Leonis min.	„	+1·127	11 6 49·56	10 46 21·21	−0·02	+0 18·65	+0·31	9·41
	ψ Ursæ maj.	W	−1·015	11 24 1·91	11 2 40·47	−0·04	+1 12·48	−0·28	9·28
	ξ Ursæ maj.	„	−1·157	11 31 46·22	11 11 32·73	−0·05	+0 4·23	−0·32	9·63
Mar. 11, 1st group	*ζ* Geminorum	W	−1·296	7 15 36·03	6 56 42·64	+0·03	−1 13·82	−0·30	−0 20 7·48
	63 Aurigæ	„	−1·078	7 24 22·91	7 3 4·57	+0·02	+1 10·97	−0·25	7·60
	65 Aurigæ	E	+1·104	7 34 38·44	7 13 42·64	+0·01	+0 47·93	+0·26	7·60
	63 Geminorum	„	+1·284	7 39 20·36	7 20 20·25	+0·01	−1 7·60	+0·30	7·40
	f Geminorum	W	−1·333	7 50 52·24	7 32 16·50	0·00	−1 31·29	−0·31	7·34
	π Geminorum	„	−1·141	7 59 55·40	7 39 28·09	0·00	+0 19·91	−0·26	7·66
	6 Cancri	E	+1·205	8 15 36·85	7 55 51·71	−0·01	−0 22·62	+0·28	7·49
	ψ^2 Cancri	„	+1·233	8 22 25·95	8 2 56·79	−0·02	−0 38·49	+0·28	7·39
	χ Cancri	W	−1·212	8 32 10·84	8 12 29·72	−0·02	−0 25·93	−0·28	7·35
	ϕ^1 Cancri	„	−1·204	8 38 39·01	8 18 52·99	−0·03	−0 21·10	−0·28	7·43
Mar. 11, 2nd group	42 Leonis min.	E	+1·168	10 59 5·51	10 38 56·74	+0·02	+0 0·91	+0·25	−0 20 7·59
	46 Leonis min.	„	+1·127	11 6 48·14	10 46 21·21	+0·02	+0 18·97	+0·25	7·69
	ψ Ursæ maj.	W	−1·015	11 24 0·35	11 2 40·47	+0·01	+1 12·65	−0·22	7·44
	ξ Ursæ maj.	„	−1·157	11 31 44·72	11 11 32·74	0·00	+0 4·63	−0·25	7·60
	58 Ursæ maj.	„	−1·029	11 44 49·52	11 23 47·57	−0·01	+0 54·73	−0·22	7·45
	61 Ursæ maj.	„	−1·126	11 54 51·76	11 34 30·17	−0·01	+0 14·31	−0·25	7·54
	1 Comæ	E	+1·273	12 15 7·70	11 55 21 94	−0·03	−0 21·77	+0·28	7·28
Mar. 11, 3rd group	*β* Coronæ	E	+1·189	15 42 56·17	15 22 41·79	+0·02	+0 7·11	+0·24	−0 20 7·01
	δ Coronæ	W	−1·226	16 4 49·57	15 44 22·14	0·00	+0 20·63	−0·25	7·05

OBSERVATIONS WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH. OBSERVER, MR. GILL; CHRONOMETER 43 (*continued*).

Date, 1875	Star	Position of circle	C	Concluded chronometer time of transit over wire III.			R.A. of star, including daily aberration			Rate of chronometer to epoch	t−m		Cc	Chronometer correction		
				h.	m.	s.	h.	m.	s.	s.	m.	s.	s.	h.	m.	s.
Mar. 11, 3rd group (*cont.*)	λ Coronæ	W	−1·088	16	10	48·83	15	51	15·91	0·00	−0	34·02	−0·22	−0	20	7·16
	τ Coronæ	E	+1·105	16	24	2·87	16	4	25·14	−0·01	−0	29·73	+0·23			7·24
	υ Coronæ	,,	+1·190	16	32	1·83	16	11	45·26	−0·01	+0	9·25	+0·25			7·08
Mar. 12, 1st group	θ Geminorum	W	−1·137	7	5	2·67	6	44	33·93	+0·05	+0	22·94	−0·18	−0	20	5·93
	ζ Geminorum	E	+1·296	7	15	35·12	6	56	42·62	+0·04	−1	13·64	+0·21			5·89
	63 Aurigæ	,,	+1·078	7	24	21·89	7	3	4·55	+0·03	+1	11·11	+0·17			6·03
	65 Aurigæ	W	−1·104	7	34	36·29	7	13	42·62	+0·02	+0	47·85	−0·18			5·98
	63 Geminorum	,,	−1·284	7	39	17·92	7	20	20·22	+0·02	−1	7·73	−0·20			5·61
	f Geminorum	E	+1·333	7	50	51·28	7	32	16·49	0·00	−1	31·21	+0·21			5·79
	π Geminorum	,,	+1·141	7	59	54·30	7	39	28·08	0·00	+0	20·07	+0·18			5·97
	6 Cancri	W	−1·205	8	15	34·69	7	55	51·70	−0·02	−0	22·79	−0·19			5·99
	ψ² Cancri	,,	−1·233	8	22	23·73	8	2	56·77	−0·02	−0	38·58	−0·20			5·76
	39 Cancri	E	+1·301	8	51	49·44	8	32	56·26	−0·05	−1	12·73	+0·21			5·75
	ι Cancri	,,	+1·193	8	59	0·89	8	39	9·45	−0·06	−0	14·39	+0·19			5·70
Mar. 12, 2nd group	ψ Ursæ maj.	E	+1·015	11	24	0·27	11	2	40·47	+0·02	+1	13·88	+0·18	−0	20	5·72
	ξ Ursæ maj.	,,	+1·157	11	31	43·58	11	11	32·74	+0·01	+0	4·93	+0·21			5·69
	61 Ursæ maj.	W	−1·126	11	54	49·90	11	34	30·18	−0·01	+0	14·30	−0·20			5·63
	1 Comæ	E	+1·273	12	15	6·20	11	55	21·95	−0·03	−0	21·48	+0·23			5·53
Mar. 13, 1st group	6 Cancri	E	+1·205	8	15	33·05	7	55	51·69	+0·01	−0	22·51	+0·13	−0	20	3·73
	ψ² Cancri	,,	+1·233	8	22	22·27	8	2	56·76	+0·01	−0	38·25	+0·14			3·61
	39 Cancri	W	−1·301	8	51	47·08	8	32	56·26	−0·01	−1	12·65	−0·14			3·62
	ι Cancri	,,	−1·193	8	58	58·69	8	39	9·44	−0·01	−0	14·33	−0·13			3·72
Mar. 13, 2nd group	46 Leonis min.	E	+1·127	11	6	45·28	10	46	21·22	+0·01	+0	19·97	+0·11	−0	20	3·97
	ψ Ursæ maj.	W	−1·015	11	23	57·21	11	2	40·47	+0·01	+1	13·17	−0·10			3·66
	ξ Ursæ maj.	,,	−1·157	11	31	41·40	11	11	32·75	0·00	+0	5·01	−0·12			3·76
	58 Ursæ maj.	,,	−1·029	11	44	44·64	11	23	47·58	0·00	+0	53·57	−0·10			3·59
	61 Ursæ maj.	,,	−1·126	11	54	48·00	11	34	30·19	0·00	+0	14·35	−0·11			3·57
	B.A.C. 4005	E	+1·408	12	3	50·31	11	44	32·10	−0·01	−0	45·41	+0·14			3·49
	1 Comæ	,,	+1·273	12	15	3·52	11	55	21·96	−0·01	−0	22·11	+0·13			3·55
Mar. 13, 3rd group	α Scorpii	E	+2·242	16	45	59·07	16	21	45·41	0·00	+4	10·34	+0·19	−0	20	3·13
	ζ Herculis	W	−1·162	16	56	35·21	16	36	35·25	0·00	−0	3·03	−0·10			3·10
	ε Herculis	E	+1·170	17	15	35·45	16	55	31·05	−0·01	+0	1·32	+0·10			2·99
Mar. 14	33 Leonis min.	E	+1·148	10	44	59·43	10	24	47·53	+0·04	+0	10·35	+0·10	−0	20	1·41
	42 Leonis min.	W	−1·168	10	58	59·45	10	38	56·75	+0·02	+0	1·25	−0·10			1·53
	46 Leonis min.	,,	−1·127	11	6	41·94	10	46	21·22	+0·01	+0	19·29	−0·10			1·52
	ψ Ursæ maj.	E	+1·015	11	23	55·45	11	2	40·48	0·00	+1	13·51	+0·09			1·37
	ξ Ursæ maj.	,,	+1·157	11	31	39·58	11	11	32·76	−0·01	+0	5·25	+0·10			1·48
	58 Ursæ maj.	W	−1·029	11	44	44·36	11	23	47·60	−0·03	+0	55·62	−0·09			1·26
	61 Ursæ maj.	,,	−1·126	11	54	46·36	11	34	30·20	−0·04	+0	14·96	−0·10			1·34
Mar. 15	f Leonis	E	+1·177	9	56	11·15	9	36	15·37	+0·02	−0	3·62	+0·15	−0	19	59·23
	μ Leonis	,,	+1·224	10	5	12·97	9	45	40·90	+0·01	−0	27·23	+0·16			59·13
	Piazzi IX. 230	W	−1·275	10	15	4·98	9	55	52·45	0·00	−0	46·37	−0·17			59·07
	μ Ursæ maj.	,,	−1·047	10	36	8·24	10	14	55·02	−0·02	+1	14·07	−0·14			59·31

Taking the means of the separate groups, the resulting chronometer corrections are :—

With the Troughton and Simms' Altazimuth.

Observer, Mr. Gill ; Chronometer 43.

Date	Epoch by chronometer	Chronometer correction to local sidereal time		
	h. m.		h. m. s.	h. m. s.
1875, Feb. 19, 1st group . .	7 34	Circle E	−0 20 44·680	−0 20 44·74
		„ W	44·805	
„ Feb. 19, 2nd group . .	11 18	Circle E	−0 20 44·323	−0 20 44·32
		„ W	44·317	
„ Feb. 20, 1st group . .	7 36	Circle E	−0 20 42·700	−0 20 42·71
		„ W	42·710	
„ Feb. 20, 2nd group . .	11 8	Circle E	−0 20 42·350	−0 20 42·35
		„ W	42·350	
„ Feb. 23, 1st group . .	7 48	Circle E	−0 20 37·076	−0 20 37·09
		„ W	37·102	
„ Feb. 23, 2nd group . .	11 21	Circle E	−0 20 36·863	−0 20 36·86
		„ W	36·858	
„ Feb. 25	8 0	Circle E	−0 20 32·833	−0 20 32·86
		„ W	32·878	
„ Feb. 27	10 59	Circle E	−0 20 28·947	−0 20 28·93
		„ W	28·920	
„ Feb. 28, 1st group . .	10 46	Circle E	−0 20 27·016	−0 20 27·02
		„ W	27·015	
„ Feb. 28, 2nd group . .	17 4	Circle E	−0 20 26·595	−0 20 26·59
		„ W	26·590	
„ Mar. 3, 1st group . . .	8 24	Circle E	−0 20 22·228	−0 20 22·22
		„ W	22·222	
„ Mar. 3, 2nd group . .	12 2	Circle E	−0 20 22·185	−0 20 22·18
		„ W	22·185	

With Dr. Löw's Transit Instrument.

Observer, Dr. Löw ; Chronometer Nieberg.

Date	Epoch by chronometer	Chronometer correction to local sidereal time		
	h. m. s.		h. m. s.	h. m. s.
1875, Mar. 3, 1st group . . .	11 11 0·00	Circle E	−3 3 33·125	−3 3 33·19
		„ W	33·253	

Observer, Mr. Gill ; Chronometer 43.

Date	Epoch by chronometer	Chronometer correction to local sidereal time		
	h. m.		h. m. s.	h. m. s.
1875, Mar. 3	10 7	Circle E	−0 20 22·125	−0 20 22·17
		„ W	22·216	

Observer, Dr. Löw ; Chronometer Nieberg.

Date	Epoch by chronometer	Chronometer correction to local sidereal time		
	h. m. s.		h. m. s.	h. m. s.
1875, Mar. 3, 2nd group . .	14 44 0·00	Circle E	−3 2 58·010	−3 2 57·85
		„ W	57·690	

With the Troughton and Simms' Altazimuth.

Observer, Mr. Gill; Chronometer 43.

Date	h.	m.	Chronometer correction to local sidereal time	h.	m.	s.	h.	m.	s.
1875, Mar. 10, 1st group . .	8	2	Circle E	−0	20	9·390	−0	20	9·39
			„ W			9·400			
„ Mar. 10, 2nd group . .	10	48	Circle E	−0	20	9·250	−0	20	9·25
			„ W			9·252			
„ Mar. 11, 1st group . .	7	57	Circle E	−0	20	7·470	−0	20	7·47
			„ W			7·477			
„ Mar. 11, 2nd group . .	11	34	Circle E	−0	20	7·520	−0	20	7·51
			„ W			7·508			
„ Mar. 11, 3rd group . .	16	11	Circle E	−0	20	7·110	−0	20	7·11
			„ W			7·105			
„ Mar. 12, 1st group . .	7	56	Circle E	−0	20	5·855	−0	20	5·85
			„ W			5·854			
„ Mar. 12, 2nd group . .	11	46	Circle E	−0	20	5·647	−0	20	5·64
			„ W			5·630			
„ Mar. 13, 1st group . .	8	37	Circle E	−0	20	3·670	−0	20	3·67
			„ W			3·670			
„ Mar. 13, 2nd group . .	11	43	Circle E	−0	20	3·670	−0	20	3·66
			„ W			3·645			
„ Mar. 13, 3rd group . .	16	59	Circle E	−0	20	3·060	−0	20	3·08
			„ W			3·100			
„ Mar. 14	11	21	Circle E	−0	20	1·420	−0	20	1·42
			„ W			1·412			
„ Mar. 15	10	13	Circle E	−0	19	59·180	−0	19	59·18
			„ W			59·190			

On February 19, 20, 23, and 24, 1875, signals were exchanged between Suez and Alexandria to determine the difference of longitude between the two stations. On the first three days time observations were secured before and after the exchanges of signals, but on the 24th no observations could be obtained. The correction of chronometer 43 for this night has been determined by means of the stationary chronometers in the following manner:—

Using the time determinations on February 23 and 25, and assuming the *hourly* rate of chronometer 43 to be $+0^{s}\cdot065$ and $+0^{s}\cdot083$ for these days respectively, we get from the comparisons of (43) with (36) the correction of chronometer 36 to local mean time, about the time of its comparison with the stationary chronometers.

Feb. 23.

At 11 h. 44 m. by (36) + 1 h. 48 m. 29·99 s.

and *hourly* rate −0·086 s.

Feb. 25.

At 10 h. 38 m. by (36) + 1 h. 48 m. 25·98 s.

With these corrections and rates we derive from the comparisons of (36) with the stationary chronometers the corrections in *seconds* of each stationary chronometer to local mean time.

Feb. 23.

Time by (36)	Stationary chronometer	Seconds of correction to local mean time
		s.
h. m.	(30)	− 8·47
	(32)	− 1·07
	(33)	−24·87
11 52	(34)	− 4·27
	(35)	−42·42
	(37)	−21·62
	(42)	− 12·80

Feb. 25.

Time by (36)	Stationary chronometer	Seconds of correction to local mean time
		s.
	(30)	−29·54
	(32)	− 4·84
	(33)	−31·89
h. m.	(34)	− 3·12
10 50	(35)	−43·79
	(37)	−26·94
	(42)	−13·74

Interpolating between February 23 and 25, the comparisons of the stationary chronometers with chronometer 36 on February 24 show the corrections for (36) to local mean time to have been—

FEB. 24.

	h.	m.	s.
At 10 35 by (36) correction of (36) to local mean time by (30) . . .	+1	48	27·89
(32) . . .			28·06
(33) . . .			28·23
(34) . . .			28·04
(35) . . .			28·02
(37) . . .			28·01
(42) . . .			28·25
By its own rate . . .			28·04
Mean . . .	+1	48	28·07 ± 0·03

Using this correction for chronometer 36, and taking the mean of the comparisons of (36) with (43), we finally obtain the corrections—

	h.	m.	s.	Weight
At 10 58 by (43) correction of (43) to local sid. time by eight M.T. chronometers .	−0	20	34·58	8
" " " by its own rate . . .			34·73	1

	h.	m.	s.
Therefore at 10 58 by (43) correction of (43) to Alexandria sid. time . . .	−0	20	34·60
Hourly rate .			+0·089

On February 28, March 6, 7, 10, 12, 13, and 14, 1875, signals were exchanged between Alexandria and Berlin, and on March 10, 11, 12, 14, and 15 between Alexandria and Malta, to determine the differences of longitude, and on March 3 observations for personal equation in determining the time were made. We now give the corrections of the chronometers used in these various operations, and the methods by which they have been found.

1875, *February* 28.—Chronometer 36 was used on this night for the exchange of signals with Berlin, and its correction and rate have been obtained by comparison with the observing chronometer 43.

Using the corrections of (43) given by the two groups of time determinations and the resulting *hourly* rate of +0ˢ·068, we get the corrections of (36) to local mean time. The mean of the comparisons of these two chronometers before and after each group of observations thus give—

Before and after 1st group of observations.				*Before and after 2nd group of observations.*			
	h.	m.	s.		h.	m.	s.
At 10 1 by (36) .	+1	48	19·01	At 16 21 by (36) .	+1	48	18·52

And *hourly* rate −0ˢ·077

Then, from the comparisons of (36) with (43) before and after the exchange of signals and the preceding errors and rates, we obtain the following corrections of (36) :—

	h.	m.	s.
By chronometer 43 at 13 59·3 by (36) correction of (36) to Alexandria mean time	+1	48	18·62
By its own rate " " " "			18·70
By chronometer 43 at 15 40·9 by (36) " " "	+1	48	18·54
By its own rate " " " "			18·57

Taking the means, we have as final corrections of chronometer 36 to local mean time—

	h.	m.				h.	m.	s.
At	13	59·3	by (36)	correction to Alexandria mean time		+1	48	18·66
At	15	40·9		„ „ „		+1	48	18·56
				And *hourly* rate .				−0·0592

1875, *March* 3.—This day was devoted to the determination of personal equation, and the corrections of the chronometers directly determined by the observations have been used.

As there were no observations for time between March 3 and 10, the corrections of chronometer 43 at the times of exchange of signals with Berlin on March 6 and 7 have been determined by means of the stationary chronometers.

On March 3 the stationary chronometers were compared with chronometer 36. Using the time determinations and assuming the *hourly* rate of chronometer 43 to be $+0^{s}\cdot011$, we derive from the comparisons of (43) with (36) the correction of (36) to local mean time about the time of its comparison with the stationary chronometers—

	h.	m.		h.	m.	s.		s.
At	12	18	by (36)	+1	48	11·66	assumed *hourly* rate	−0·093

On March 10 the stationary chronometers were compared with chronometer 43 by coincident beats. Taking the correction of (43) given by the observations with the resulting rate $+0^{s}\cdot051$ per hour, we find, with the correction of (36) given above, the following corrections in seconds of each stationary chronometer to local mean time on March 3 and 10 :—

March 3.			March 10.		
Stationary chronometer	Time by stationary chronometer h. m.	Seconds of correction to local mean time s.	Stationary chronometer	Time by stationary chronometer h. m.	Seconds of correction to local mean time s.
(30)	12 31	−34·84	(30)	7 44	−108·32
(32)	12 48	−19·14	(32)	8 7	− 36·64
(33)	12 16	−51·84	(33)	7 43	− 73·98
(34)	12 3	− 1·34	(34)	7 40	− 0·05
(35)	12 12	−50·84	(35)	7 56	− 58·12
(37)	12 16	−45·79	(37)	8 4	− 66·44
(42)	12 11	−17·34	(42)	8 5	− 21·36

Interpolating between March 3 and 10, the comparisons of the stationary chronometers with chronometer 36 give—

1875, March 6.

Correction of Chronometer 36 *to local mean time.*

At 10 h. 13 m. by (36)				At 15 h. 7 m. by (36)			
	h.	m.	s.		h.	m.	s.
By chronometer (30)	+1	48	4·56	By chronometer (30)	+1	48	4·30
(32)			4·77	(32)			4·30
(33)			4·30	(33)			3·83
(34)			5·06	(34)			4·80
(35)			4·85	(35)			4·44
(37)			4·80	(37)			4·38
(42)			4·55	(42)			4·23
Mean . .	+1	48	4·70	Mean . .	+1	48	4·33

Resulting *hourly* rate $-0^{s}\cdot076$

1875, MARCH 7.

Correction of Chronometer 36 *to local mean time.*

At h. 8 m. 29 by (36)				At h. 14 m. 36 by (36)			
	h.	m.	s.		h.	m.	s.
By chronometer (30)	+1	48	2·74	By chronometer (30)	+1	48	2·18
(32)			2·99	(32)			2·38
(33)			2·33	(33)			1·85
(34)			3·19	(34)			2·53
(35)			2·66	(35)			2·24
(37)			2·70	(37)			2·22
(42)			2·50	(42)			1·95
Mean . .	+1	48	2·73	Mean . .	+1	48	2·19

Resulting *hourly* rate $-0^s\cdot088$

And from the comparisons of (36) with (43) about these times, we have—

1875, MARCH 6.

			h.	m.	s.
At h. 11 m. 26·6 by (43)	correction of (43) to Alexandria sidereal time		−0	20	16·46
At 16 3·9 by (43)	„ „ „		−0	20	16·13

Resulting *hourly* rate $+0^s\cdot071$

1875, MARCH 7.

			h.	m.	s.
At h. 9 m. 47·3 by (43)	correction of (43) to Alexandria sidereal time		−0	20	14·77
At 15 38·8 by (43)	„ „ „		−0	20	14·46

Resulting *hourly* rate $+0^s\cdot053$

From the comparisons of chronometers 36 and 43 about the times of exchange of signals and the preceding corrections and rates, we obtain as final corrections of (43)—

1875, MARCH 6.

				h.	m.	s.	Seconds of adopted mean
By chronometer 36 at h. 13	m. 19·6 by (43)	correction of (43) to Alexandria sidereal time		−0	20	16·25	16·29
By its own rate	„	„	„			16·33	
By chronometer 36 at 14	46·7 by (43)	correction of (43) to Alexandria sidereal time		−0	20	16·18	16·20
By its own rate	„	„	„			16·22	

Resulting *hourly* rate $+0^s\cdot062$

1875, MARCH 7.

				h.	m.	s.	
By chronometer 36 at h. 12	m. 30·0 by (43)	correction of (43) to Alexandria sidereal time		−0	20	14·61	14·62
By its own rate	„	„	„			14·63	
By chronometer 36 at 15	6·5 by (43)	correction of (43) to Alexandria sidereal time		−0	20	14·45	14·47
By its own rate	„	„	„			14·49	

Resulting *hourly* rate $+0^s\cdot058$

On March 10, &c., the interval between the observations for time and the exchange of signals was generally too great to admit of trusting to the rate of the chronometer used in the observations for carrying on the time. The rates of the stationary chronometers have therefore been brought in to accomplish this object.

From the comparisons of the stationary chronometers with (43) on March 10 and 13, the last day on which they were all compared, we find the following *hourly* rates, which have been used whenever the stationary chronometers have subsequently been employed :—

Chronometer	(30)	(32)	(33)	(34)	(35)	(37)	(42)
Hourly rate	s. −0·4388	s. −0·1073	s. −0·1457	s. +0·0251	s. −0·0395	s. −0·1345	s. −0·0220

1875, *March* 10.—From the corrections of (43) determined by observation, and the comparisons of (43) with the stationary chronometers between the groups of time determinations, we derive the corrections for each of the stationary chronometers :—

Chronometer	Time by chronometer	Correction to Alexandria mean time
	h. m.	h. m. s.
(30)	7 44·3	+1 37 11·68
(32)	8 6·6	+1 21 23·36
(33)	7 43·4	+1 52 46·02
(34)	7 39·7	+2 5 59·95
(35)	7 56·3	+1 56 1·88
(37)	8 4·4	+1 52 53·56
(42)	8 5·3	+1 57 38·64

Using these corrections and the rates previously given, we deduce the corrections of chronometer 43 by each stationary chronometer :—

Stationary chronometer	Time by (43)	Correction of (43) to local sidereal time	Stationary chronometer	Time by (43)	Correction of (43) to local sidereal time
	h. m.	h. m. s.		h. m.	h. m. s.
(30)	11 53·9	−0 20 9·16	(30)	18 2·2	−0 20 8·51
(32)	12 1·4	9·25	(32)	18 4·4	8·93
(33)	12 4·6	9·11	(33)	18 7·0	8·68
(34)	12 7·8	9·22	(34)	18 10·3	8·68
(35)	12 12·7	9·18	(35)	18 14·3	8·67
(37)	12 19·2	9·19	(37)	18 18·2	8·67
(42)	12 24·4	9·20	(42)	18 20·9	8·67
Mean . .	12 9	−0 20 9·19	Mean . .	18 11	−0 20 8·69

Resulting *hourly* rate +0ˢ·083

And from the comparisons of chronometers 43 and 36 we get the following corrections of (36) to local mean time :—

	h.	m.		h.	m.	s.		
At	10	46·7	by (36)	+1	47	56·09		
At	16	36·3	by (36)	+1	47	55·40		

And *hourly* rate −0ˢ·118

With these corrections and rates, we obtain from the comparisons of chronometers 36 and 43 at the telegraph office, the corrections of chronometer 43 at the times of exchange of signals :—

	h.	m.				h.	m.	s.	Seconds of adopted mean
By chronometer 36 at	12	51·5	by (43) correction of (43) to Alexandria sidereal time	.	.	−0	20	9·08	9·11
By its own rate	„		„	„	„			9·13	
			Hourly rate +0ˢ·088						
By chronometer 36 at	15	25·8	by (43) correction of (43) to Alexandria sidereal time	.	.	−0	20	8·86	8·89
By its own rate	„		„	„	„			8·92	
			Hourly rate +0ˢ·076						
By chronometer 36 at	17	24·0	by (43) correction of (43) to Alexandria sidereal time	.	.	−0	20	8·72	8·74
By its own rate	„		„	„	„			8·76	

1875, *March* 11.—There being time determinations both before and after the exchange of signals, there was no necessity for using the stationary chronometers to carry on the time. It has, however, been thought advisable to use chronometer 36 as well as 43 to interpolate the correction of (43) at the times of exchange of signals.

Combining the corrections of chronometer 43 ascertained by observations, and the comparisons of (43) and (36) at the times of observation, the resulting corrections of (36) to local mean time are—

h.	m.		h.	m.	s.		h.	m.		h.	m.	s.
At 10	10·9	by (36)	+1	47	53·86		At 14	40·6	by (36)	+1	47	53·69

And *hourly* rate −0ˢ·038

Then, from the comparisons of (36) and (43) at the telegraph office, we have corrections of chronometer 43 at the times of exchange of signals :—

	h.	m.				h.	m.	s.	Seconds of adopted mean
By chronometer 36 at	12	52·5	by (43) correction of (43) to Alexandria sidereal time	.	.	−0	20	7·44	7·42
By its own rate	„		„	„	„			7·40	
By chronometer 36 at	15	15·4	by (43) correction of (43) to Alexandria sidereal time	.	.	−0	20	7·13	7·16
By its own rate	„		„	„	„			7·19	

Resulting *hourly* rate +0ˢ·109

1875, *March* 12.—From the corrections of chronometer 43 determined by observation, and the comparisons of the stationary chronometers with it between the groups of time determinations, we find the corrections for each of the stationary chronometers :—

Chronometer	Time by chronometer h. m.	Correction to Alexandria mean time h. m. s.
(30)	7 57·2	+1 36 50·57
(32)	8 16·0	+1 21 18·05
(33)	7 46·6	+1 52 39·22
(34)	7 36·1	+2 6 1·26
(35)	7 49·0	+1 56 0·03
(37)	7 57·6	+1 52 47·40
[(42)	7 54·5	+1 57 45·59 *]

[*] There is some mistake in this comparison ; it cannot be used.

Using these corrections and the rates previously given, we obtain the following corrections of (43) by each stationary chronometer :—

Stationary chronometer	Time by (43) h. m.	Correction of (43) to local sidereal time h. m. s.
(30)	19 1·5	−0 20 4·86
(32)	19 2·5	4·97
(33)	19 5·1	4·75
(34)	19 7·1	4·73
(35)	19 10·3	4·81
(37)	19 15·7	4·73
Mean	19 7	−0 20 4·81

Combining this correction with that previously determined by observation, there results—

Hourly rate of chronometer 43 . . . . . $+0^s\cdot101$

And from the comparisons of (43) and (36), we then find the corrections of (36) to local mean time :—

h. m.		h. m. s.		h. m.		h. m. s.
At 7 57·9	by (36)	+1 47 52·05	At 17	28·2	by (36)	+1 47 51·16

And *hourly* rate $-0^s\cdot094$

These corrections and rates, combined with the comparisons of chronometers 36 and 43 at the telegraph office, afford the subjoined final corrections of (43) at the times of exchange of signals :—

	h. m. s.	Seconds of adopted mean
By chronometer 36 at 12 47·2 by (43) correction of (43) to Alexandria sidereal time .	−0 20 5·48	5·47
By its own rate " " " "	5·45	
Hourly rate $+0^s\cdot118$		
By chronometer 36 at 15 32·8 by (43) correction of (43) to Alexandria sidereal time .	−0 20 5·11	5·14
By its own rate " " " "	5·17	
Hourly rate $+0^s\cdot105$		
By chronometer 36 at 18 0·8 by (43) correction of (43) to Alexandria sidereal time .	−0 20 4·84	4·88
By its own rate " " " "	4·92	
Hourly rate $+0^s\cdot071$		
By chronometer 36 at 18 42·6 by (43) correction of (43) to Alexandria sidereal time .	−0 20 4·81	4·83
By its own rate " " " "	4·85	

1875, *March* 13.—There being time determinations before and after the exchange of signals, chronometers 36 and 43 only have been used to interpolate the correction of (43) at the times of exchange of signals.

The corrections of (43) determined by observations, and the comparisons of the two chronometers at the time of these observations, give the corrections of (36) to local mean time :—

h. m.		h. m. s.		h. m.		h. m. s.
At 9 40·7	by (36)	+1 47 49·58	At 15	21·9	by (36)	+1 47 49·10

And *hourly* rate $-0^s\cdot084$

The comparisons of chronometers 36 and 43 at the telegraph office then give as final corrections of chronometer 43 at the times of exchange of signals—

				Seconds of adopted mean
By chronometer 36 at 12 52·7 by (43) correction of (43) to Alexandria sidereal time .	−0 20 3·46	3·495
By its own rate " " " "	3·53	
Hourly rate +0ˢ·116		
By chronometer 36 at 14 15·3 by (43) correction of (43) to Alexandria sidereal time .	−0 20 3·29	3·335
By its own rate " " " "	3·38	
Hourly rate +0ˢ·110		
By chronometer 36 at 16 1·2 by (43) correction of (43) to Alexandria sidereal time .	−0 20 3·09	3·140
By its own rate " " " "	3·19	

1875, *March* 14.—Of the stationary chronometers, only (35) and (42) were compared on this date; the carrying on of the time therefore depends upon the uniformity of their rates. From their comparisons with (43), using the correction determined by observations for this chronometer, we have—

Chronometer	Time by chronometer	Correction to Alexandria mean time
	h. m.	h. m. s.
(35)	9 23·5	+1 55 57·73
(42)	9 31·2	+1 57 36·20

And then, by using the previously determined rates, we find—

Stationary chronometer	Time by (43)	Correction of (43) to local sidereal time
	h. m.	h. m. s.
(35)	17 22·8	−0 20 0·75
(42)	17 28·3	0·77
Mean . . .	17 25·6	−0 20 0·76

Combining this correction with that previously determined by observation, there results—

Hourly rate of chronometer 43 +0ˢ·109

And from the comparisons of (43) and (36) follow the corrections of (36) to local mean time—

h. m. h. m. s.	h. m. h. m. s.
At 9 22·5 by (36) +1 47 47·23	At 15 38·1 by (36) +1 47 46·70

And *hourly* rate −0ˢ·085

Applying these corrections and rates to the comparisons of chronometers 36 and 43 at the telegraph office, we derive the final corrections for chronometer 43 at the times of exchange of signals as follow :—

			Seconds of adopted mean
By chronometer 36 at 13 0·0 by (43) correction of (43) to Alexandria sidereal time .	−0 20 1·23	1·235
By its own rate " " " "	1·24	
Hourly rate +0ˢ·124		
By chronometer 36 at 14 36·8 by (43) correction of (43) to Alexandria sidereal time .	−0 20 1·00	1·035
Byits own rate " " " "	1·07	
Hourly rate +0ˢ·107		
By chronometer 36 at 14 56·8 by (43) correction of (43) to Alexandria sidereal time .	−0 20 0·76	0·785
By its own rate " " " "	0·81	

The final corrections of the chronometers 36 and 43 thus arrived at have been used for reducing to Alexandria sidereal time the whole of the signals exchanged with Suez, Malta, and

Berlin. In the case of the signals sent to and received from Suez, and which are contained in the next table, the corrected Alexandria times have already been given along with the corresponding Suez times in the deduction of the difference of longitude in Chapter XIV.

SIGNALS SENT TO AND RECEIVED FROM SUEZ.

1875, FEBRUARY 19

Number of signal	SET 1	SET 2	SET 3	SET 4
	Time by chronometer 43	Time by chronometer 43	Time by chronometer 43	Time by chronometer 43
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	9 30 41·7	9 40 49·6	9 50 35·2	9 57 10·4
2	51·7	41 9·7	55·0	30·7
3	31 21·8	19·8	51 5·2	40·1
4	31·9	30·2	25·3	50·2
5	41·9	42 10·2	36·0	58 20·4
6	51·9	20·2	45·1	30·6
7	32 1·9	30·3	55·3	40·3
8	32·1	40·0	52 5·0	50·0
9	42·1	50·2	35·4	59 10·7
10	52·0	43 20·5	54 5·5	20·0
11	33 2·1	40·6	25·6	30·4
12	22·2	50·4	45·7	40·2
13	32·1	44 20·1	55·6	10 0 10·0
14	42·1	30·4	55 5·8	20·0
15	34 22·2	41·1	25·9	30·6
16	32·3	50·4	9 55 56·0	40·2
17	42·3	45 10·1	...	1 10·1
18	52·3	19·8	...	20·2
19	35 2·3	30·2	...	40·3
20	32·4	40·5	...	50·1
21	52·7	46 10·0	...	2 10·2
22	9 36 2·6	20·1	...	20·3
23	...	30·2	...	30·4
24	...	9 46 50·1	...	10 2 50·3

1875, FEBRUARY 20

Number of signal	SET 5	SET 6	SET 7	SET 8
	Time by chronometer 43	Time by chronometer 43	Time by chronometer 43	Time by chronometer 43
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	8 59 57·1	9 6 57·0	9 18 10·6	9 25 0·4
2	9 0 7·4	7 7·0	20·6	10·2
3	27·9	17·2	30·6	40·0
4	57·5	27·4	50·7	26 0·5
5	1 7·9	57·0	19 0·5	30·5
6	18·0	8 7·3	10·6	40·5
7	28·3	17·5	20·8	27 10·5
8	47·7	27·4	31·0	20·9
9	57·7	37·3	20 1·0	30·6
10	2 7·9	58·0	11·2	41·0
11	18·0	9 18·1	21·2	28 1·0
12	28·0	28·2	31·0	11·2
13	48·0	38·2	51·0	21·1
14	58·1	57·8	21 1·2	31·0
15	3 8·2	10 8·0	11·3	41·0
16	18·8	18·1	21·0	29 11·2
17	48·0	28·1	31·2	21·4
18	57·8	38·0	51·2	31·0
19	4 8·2	58·2	22 1·1	41·0
20	48·2	11 8·0	11·1	30 1·2
21	58·1	18·7	21·4	11·4
22	9 5 18·8	28·0	31·1	21·2
23	...	38·0	51·4	31·3
24	...	58·1	23 1·0	9 30 41·2
25	...	12 18·8	9 23 21·7	...
26	...	9 12 28·0	...	...

1875, February 23				
Number of signal	Set 9	Set 10	Set 11	Set 12
	Time by chronometer 43	Time by chronometer 43	Time by chronometer 43	Time by chronometer 43
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	9 20 46·6	9 29 47·0	9 44 0·6	9 55 51·8
2	56·7	57·1	10·6	56 1·7
3	21 6·6	30 7·7	20·0	12·1
4	16·6	27·6	40·8	32·0
5	36·8	47·3	50·6	51·9
6	46·9	57·8	45 0·6	57 1·9
7	57·0	31 8·0	10·7	22·1
8	22 6·8	18·0	20·7	32·2
9	16·7	28·1	41·0	52·1
10	37·4	57·7	50·9	58 22·3
11	47·0	32 7·9	46 1·0	32·3
12	57·1	18·0	21·0	52·1
13	23 6·8	27·6	47 1·0	59 2·0
14	16·6	47·7	11·2	12·8
15	37·3	57·6	20·8	22·9
16	47·1	33 8·1	41·1	32·8
17	57·1	18·1	48 1·0	52·1
18	24 7·3	47·4	11·2	10 0 22·9
19	17·0	34 18·1	20·9	33·0
20	37·0	28·0	50·7	52·4
21	47·2	48·0	49 1·4	1 3·0
22	57·4	57·8	41·4	12·9
23	9 25 7·6	35 18·7	51·7	23·1
24	...	28·3	50 1·3	10 1 32·8
25	...	48·0	11·3	...
26	...	58·2	21·1	...
27	...	36 8·7	41·4	...
28	...	28·2	51·7	...
29	...	48·0	51 11·8	...
30	...	58·4	21·7	...
31	...	37 18·7	41·7	...
32	...	28·8	51·8	...
33	...	48·2	52 1·9	...
34	...	38 19·1	21·9	...
35	...	48·7	42·1	...
36	...	58·7	51·7	...
37	...	39 19·0	52 12·0	...
38	...	28·8	9 53 21·8	...
39	...	48·7	...	...
40	...	58·8	...	...
41	...	40 9·6	...	...
42	...	29·1	...	...
43	...	49·0	...	...
44	...	59·1	...	...
45	...	41 9·2	...	...
46	...	9 41 19·9	...	...

1875, February 24

Number of signal	Set 13	Set 14	Set 15	Set 16
	Time by chronometer 43	Time by chronometer 43	Time by chronometer 43	Time by chronometer 43
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	9 35 30·6	9 46 29·0	9 58 44·7	10 10 32·9
2	51·1	39·4	54·3	11 33·1
3	36 1·0	49·3	59 4·8	43·4
4	11·0	59·6	45·0	53·3
5	31·1	47 29·95	55·0	12 3·3
6	37 1·0	39·4	10 0 4·8	23·1
7	10·8	49·7	14·7	33·4
8	41·1	48 19·6	34·6	43·8
9	51·2	29·8	44·9	54·0
10	38 1·6	40·0	54·9	13 4·0
11	11·2	50·2	1 4·8	23·2
12	31·6	59·9	15·0	44·1
13	41·8	49 19·7	35·1	54·0
14	51·6	39·6	55·1	14 4·1
15	39 1·4	50·3	2 14·9	23·4
16	11·6	50 0·0	34·9	33·9
17	41·8	19·9	55·1	43·8
18	40 1·6	29·6	3 5·2	54·2
19	11·3	40·1	15·1	15 4·1
20	32·8	50·2	45·3	24·0
21	51·9	51 0·2	55·2	44·7
22	41 1·8	30·0	4 15·0	16 4·2
23	12·0	40·1	5 5·4	24·0
24	31·8	50·3	16·0	54·6
25	52·0	52 0·3	35·6	17 4·6
26	42 2·1	20·1	45·4	34·6
27	31·8	29·9	55·6	44·8
28	43 2·1	40·2	6 5·8	54·7
29	32·0	50·2	16·0	18 4·8
30	42·2	53 2·0	36·0	24·4
31	52·0	30·4	45·9	34·3
32	9 44 12·0	54 0·4	56·1	44·7
33	...	30·1	7 6·2	55·0
34	...	40·2	15·9	19 24·7
35	...	50·3	36·0	34·8
36	...	55 0·6	46·0	45·0
37	...	20·1	8 5·7	55·3
38	...	40·7	36·4	20 5·4
39	...	50·9	56·2	24·8
40	...	56 0·6	9 6·2	34·7
41	...	30·4	10 9 16·1	45·2
42	...	40·8	...	10 20 55·0
43	...	51·0	...	...
44	...	9 57 1·0	...	...

Alexandria-Malta Longitude.

The ensuing table contains the chronometer and local sidereal times of despatch and receipt of signals at Alexandria to and from Malta. In order to deduce the difference of longitude

between the two stations, the Malta sidereal times of receipt and despatch of corresponding signals at that end of the line are also given here in anticipation of the data on which they are based. We thus obtain the differences of chronometer times by each signal.

1875, MARCH 10

SET 1

Number of signal	Time by chronometer 43	Alexandria sidereal time ; signals *sent*	Corresponding Malta sidereal time ; signals *received*	Resulting longitude, Alexandria east of Malta
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 30 53·5	14 10 44·53	13 9 13·89	1 1 30·64
2	31 4·0	55·03	23·92	31·11
3	23·9	11 14·93	44·17	30·76
4	54·0	45·03	10 14·05	30·98
5	32 4·0	55·03	24·08	30·95
6	44·2	12 35·23	11 5·19	30·04
7	54·0	45·03	14·22	30·81
8	33 24·0	13 15·03	44·70	30·33
9	34·4	25·43	54·53	30·90
10	44·4	35·43	12 5·15	30·28
11	54·6	45·63	15·28	30·35
12	34 4·8	55·83	25·31	30·52
13	24·7	14 15·73	45·16	30·57
14	35·0	26·04	55·49	30·55
15	45·0	36·04	13 5·42	30·62
16	54·3	45·34	14·64	30·70
17	35 24·0	15 15·04	44·83	30·21
18	34·7	25·74	54·65	31·09
19	44·3	35·34	14 4·98	30·36
20	54·4	45·44	15·41	30·03
21	36 4·1	55·14	25·44	29·70
22	24·8	16 15·84	44·89	30·95
23	34·5	25·54	54·82	30·72
24	45·0	36·04	15 5·64	30·40
25	54·7	45·74	15·37	30·37
26	37 4·8	55·84	24·90	30·94
27	24·9	17 15·94	45·66	30·28
28	35·0	26·04	55·18	30·86
29	44·7	35·74	16 5·41	30·33
30	54·7	45·74	15·24	30·50
31	38 25·0	18 16·04	45·82	30·22
32	35·0	26·04	56·05	29·99
33	45·1	36·14	17 6·07	30·07
34	55·1	46·14	16·21	29·93
35	39 5·0	56 04	26·14	29·90
36	25·0	19 16·04	45·59	30·45
37	35·0	26·04	56·02	30·02
38	55·0	46·04	18 16·38	29·66
39	14 40 5·0	14 19 56·04	13 18 26·20	29·84

1875, MARCH 10 (*continued*)

SET 2

Number of signal	Time by chronometer 43	Alexandria sidereal time; signals *received*	Corresponding Malta sidereal time; signals *sent*	Resulting longitude, Alexandria east of Malta
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 41 41·2	14 21 32·25	13 20 1·67	1 1 30·58
2	51·2	42·25	11·69	30·56
3	42 1·0	52·05	21·72	30·33
4	11·4	22 2·45	31·75	30·70
5	41·7	32·75	21 1·83	30·92
6	51·7	42·75	11·86	30·89
7	43 1·7	52·75	21·89	30·86
8	11·8	23 2·85	31·91	30·94
9	32·0	23·05	51·97	31·08
10	41·9	32·95	22 2·00	30·95
11	52·0	43·05	12·02	31·03
12	44 2·0	53·05	22·05	31·00
13	11·9	24 2·95	32·08	30·87
14	32·0	23·05	52·13	30·92
15	42·1	33·15	23 2·16	30·99
16	45 2·0	53·05	22·21	30·84
17	12·1	25 3·15	32·24	30·91
18	32·0	23·05	52·30	30·75
19	42·1	33·15	24 2·32	30·83
20	52·1	43·15	12·35	30·80
21	46 2·0	53·05	22·38	30·67
22	12·1	26 3·15	32·41	30·74
23	32·2	23·25	52·46	30·79
24	42·2	33·25	25 2·49	30·76
25	52·2	43·25	12·52	30·73
26	47 2·2	53·25	22·54	30·71
27	12·3	27 3·35	32·57	30·78
28	32·3	23·35	52·63	30·72
29	42·8	33·85	26 2·65	31·20
30	52·4	43·45	12·68	30·77
31	48 32·3	28 23·36	52·79	30·57
32	42·6	33·66	27 2·82	30·84
33	50 2·8	29 53·86	28 23·05	30·81
34	12·8	30 3·86	33·07	30·79
35	32·9	23·96	53·13	30·83
36	43·0	34·06	29 3·16	30·90
37	53·0	44·06	13·18	30·88
38	14 51 3·0	14 30 54·06	13 29 23·21	30·85

1875, MARCH 10 (*continued*)

SET 3

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Malta sidereal time; signals *received*			Resulting longitude, Alexandria east of Malta		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	14	52	43·8	14	32	34·86	13	31	3·48	1	1	31·38
2		53	3·8			54·86			23·54			31·32
3			33·3		33	24·36			53·62			30·74
4			43·2			34·26		32	3·65			30·61
5			53·3			44·36			13·67			30·69
6		54	3·3			54·36			23·70			30·66
7			33·1		34	24·16			53·78			30·38
8			43·3			34·36		33	3·81			30·55
9		55	3·4			54·47			23·87			30·60
10			13·4		35	4·47			33·89			30·58
11			33·8			24·87			53·95			30·92
12		56	13·9		36	4·97		34	34·06			30·91
13			34·0			25·07			54·11			30·96
14			53·9			44·97		35	14·17			30·80
15		57	4·0			55·07			24·19			30·88
16			14·0		37	5·07			34·22			30·85
17			34·0			25·07			54·28			30·79
18			54·0			45·07		36	14·33			30·74
19		58	4·1			55·17			24·36			30·81
20			14·0		38	5·07			34·39			30·68
21	15	0	4·2		39	55·27		38	24·70			30·57
22			14·3		40	5·37			34·72			30·65
23			44·3			35·37		39	4·81			30·56
24			54·6			45·67			14·83			30·84
25		1	4·6			55·67			24·86			30·81
26	15	1	14·4	14	41	5·47	13	39	34·89			30·58

SET 4

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Malta sidereal time; signals *sent*			Resulting longitude, Alexandria east of Malta		
	h.	m.	s.	h.	m.	s.	h.	m.	s	h.	m.	s.
1	15	2	39·0	14	42	30·08	13	40	59·12	1	1	30·96
2			49·1			40·18		41	10·05			30·13
3			59·0			50·08			20·08			30·00
4		3	9·0		43	0·08			29·40			30·68
5			39·0			30·08			59·97			30·11
6			49·0			40·08		42	9·21			30·87
7			59·0			50·08			19·54			30·54
8		4	9·1		44	0·18			29·67			30·51
9			29·0			20·08			49·52			30·56
10			38·9			29·98			59·65			30·33
11			49·1			40·18		43	10·08			30·10
12		5	9·0		45	0·08			29·53			30·55
13			29·1			20·18			49·59			30·59
14			39·1			30·18			59·71			30·47
15			59·3			50·38		44	19·67			30·71
16		6	9·8		46	0·88			30·60			30·28
17			29·3			20·38			50·25			30·13
18			49·5			40·58		45	9·91			30·67
19		7	29·4		47	20·48			49·91			30·57
20			39·2			30·28			59·94			30·34
21			49·8			40·88		46	10·87			30·01
22		8	9·4		48	0·48			30·02			30·46
23			49·6			40·69		47	10·93			29·76
24			59·8			50·89			21·06			29·83
25		9	9·7		49	0·79			30·19			30·60
26			29·5			20·59			50·55			30·04
27			59·8			50·89		48	20·33			30·56
28		10	30·0		50	21·09			50·42			30·67
29			40·0			31·09		49	0·44			30·65
30			50·1			41·19			10·97			30·22
31		11	0·2			51·29			21·40			29·89
32	15	11	30·0	14	51	21·09	13	49	51·28			29·81

1875, MARCH 10 (*continued*)

SET 4 (*continued*)

Number of signal	Time by chronometer 43	Alexandria sidereal time ; signals *received*	Corresponding Malta sidereal time ; signals *sent*	Resulting longitude, Alexandria east of Malta
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
33	15 11 50·1	14 51 41·19	13 50 10·94	1 1 30·25
34	12 10·2	52 1·29	30·69	30·60
35	30·2	21·29	50·75	30·54
36	40·3	31·39	51 0·77	30·62
37	15 13 10·6	14 53 1·69	13 51 31·86	29·83

1875, MARCH 11

SET 5

Number of signal	Time by chronometer 43	Alexandria sidereal time ; signals *sent*	Corresponding Malta sidereal time ; signals *received*	Resulting longitude, Alexandria east of Malta
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 16 24·3	13 56 17·03	12 54 45·96	1 1 31·07
2	17 43·8	57 36·53	56 5·48	31·05
3	54·2	46·94	16·31	30·63
4	18 14·0	58 6·74	36·26	30·48
5	24·0	16·74	46·29	30·45
6	34·3	27·04	56·32	30·72
7	44·0	36·74	57 5·74	31·00
8	54·9	47·64	16·37	31·27
9	19 35·0	59 27·74	56·68	31·06
10	20 14·7	14 0 7·44	58 36·59	30·85
11	24·8	17·54	46·52	31·02
12	43·2	35·94	59 5·67	30·27
13	21 13·0	1 5·74	35·56	30·18
14	23·9	16·64	45·79	30·85
15	34·8	27·54	56·82	30·72
16	43·9	36·64	13 0 6·25	30·39
17	55·0	47·74	17·08	30·66
18	22 14·2	2 6·94	36·23	30·71
19	24·0	16·74	46·16	30·58
20	34·0	26·74	55·98	30·76
21	44·8	37·54	1 7·21	30·33
22	55·9	48·64	17·94	30·70
23	23 14·8	3 7·54	37·10	30·44
24	24·6	17·35	46·22	31·13
25	34·0	26·75	56·35	30·40
26	45·3	38·05	2 7·58	30·47
27	24 14·8	4 7·55	36·76	30·79
28	24·3	17·05	46·89	30·16
29	35·9	28·65	57·51	31·14
30	44·9	37·65	3 7·34	30·31
31	54·7	47·45	17·37	30·08
32	26 15·0	6 7·75	4 36·59	31·16
33	24·0	16·75	46·81	29·94
34	36·0	28·75	57·74	31·01
35	45·0	37·75	5 6·97	30·78
36	55·0	47·75	17·60	30·15
37	27 16·3	7 9·05	38·75	30·30
38	25·3	18·05	47·98	30·07
39	14 27 35·0	14 7 27·75	13 5 57·11	30·64

1875, MARCH 11 (*continued*)

SET 6

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Malta sidereal time; signals *sent*			Resulting longitude, Alexandria east of Malta		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	14	31	35·0	14	11	27·76	13	9	56·66	1	1	31·10
2			45·0			37·76		10	6·99			30·77
3			55·0			47·76			16·51			31·25
4		32	4·9			57·66			26·54			31·12
5		33	45·0		13	37·76		12	7·12			30·64
6			55·0			47·76			16·75			31·01
7		34	5·0			57·76			26·68			31·08
8			25·0		14	17·77			46·63			31·14
9			35·0			27·77			56·86			30·91
10			45·0			37·77		13	6·79			30·98
11			55·0			47·77			16·92			30·85
12		35	5·2			57·97			27·04			30·93
13			34·8		15	27·57			56·12			31·45
14			45·3			38·07		14	7·25			30·82
15			54·8			47·57			16·18			31·39
16		36	4·8			57·57			26·11			31·46
17			25·0		16	17·77			46·56			31·21
18			45·0			37·77		15	6·62			31·15
19		37	25·2		17	17·97			47·23			30·74
20			45·4			38·17		16	6·98			31·19
21		38	5·0			57·77			27·04			30·73
22			25·5		18	18·27			46·89			31·38
23			44·8			37·57		17	6·85			30·72
24		39	5·7			58·47			27·50			30·97
25			25·7		19	18·47			47·26			31·21
26			35·0			27·77			56·78			30·99
27			54·8			47·58		18	16·74			30·84
28		40	5·0			57·78			26·96			30·82
29			25·9		20	18·68			47·72			30·96
30			45·2			37·98		19	6·97			31·01
31			54·7			47·48			16·90			30·58
32	14	41	5·7	14	20	58·48	13	19	27·83			30·65

SET 7

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Malta sidereal time; signals *sent*			Resulting longitude, Alexandria east of Malta		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	14	42	46·0	14	22	38·78	13	21	8·00	1	1	30·78
2			55·9			48·68			17·33			31·35
3		43	4·9			57·68			27·36			30·32
4			25·9		23	18·68			47·41			31·27
5			45·8			38·58		22	7·67			30·91
6			56·0			48·78			17·49			31·29
7		44	46·0		24	38·78		23	7·63			31·15
8		45	5·9			58·68			27·69			30·99
9			26·2		25	18·99			48·24			30·75
10			36·0			28·79			57·77			31·02
11			45·9			38·69		24	7·80			30·89
12			57·0			49·79			18·62			31·17
13		46	46·2		26	38·99		25	8·27			30·72
14		47	26·9		27	19·69			48·08			31·61
15			56·0			48·79		26	17·96			30·83
16		48	6·2			58·99			28·09			30·90
17			26·8		28	19·59			48·24			31·35
18			36·8			29·59			58·57			31·02
19			46·5			39·29		27	8·30			30·99
20		49	6·8			59·59			28·35			31·24
21			26·8		29	19·59			48·61			30·98
22			36·0			28·79			58·13			30·66
23			46·2			38·99		28	8·46			30·53
24			56·1			48·89			18·09			30·80
25		50	7·1			59·89			28·72			31·17
26			57·5		30	50·30		29	19·16			31·14
27	14	51	7·0	14	30	59·80	13	29	28·68			31·12

1875, MARCH 11 (*continued*)

SET 8

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Malta sidereal time; signals *received*			Resulting longitude, Alexandria east of Malta		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	14	57	51·0	14	37	43·81	13	36	13·48	1	1	30·33
2		58	0·0			52·81			22·61			30·20
3			30·0		38	22·81			51·89			30·92
4			40·2			33·01		37	3·22			29·79
5			50·0			42·81			12·05			30·76
6		59	1·0			53·81			23·48			30·33
7			20·1		39	12·91			42·83			30·08
8			31·2			24·01			54·06			29·95
9			39·8			32·61		38	2·09			30·52
10			51·2			44·01			13·42			30·59
11	15	0	0·0			52·81			22·15			30·66
12			41·2		40	34·01		39	3·86			30·15
13			50·0			42·81			13·29			29·52
14		1	1·8			54·61			24·31			30·30
15			32·0		41	24·81			54·20			30·61
16			51·8			44·62		40	14·25			30·37
17		2	21·9		42	14·72			44·33			30·39
18			29·9			22·72			52·56			30·16
19			52·3			45·12		41	14·62			30·50
20		3	1·0			53·82			23·64			30·18
21			30·0		43	22·82			52·72			30·10
22			41·4			34·22		42	3·75			30·47
23			50·8			43·62			12·78			30·84
24		4	2·1			54·92			24·81			30·11
25			21·6		44	14·42			43·86			30·56
26			31·0			23·82			52·89			30·93
27			52·2			45·02		43	14·94			30·08
28		5	21·0		45	13·82			43·02			30·80
29			41·0			33·82		44	3·08			30·74
30		6	2·7			55·52			25·14			30·38
31			21·8		46	14·62			43·69			30·93
32			30·9			23·72			53·01			30·71
33	15	6	52·0	14	46	44·82	13	45	13·77			31·05

1875, MARCH 12

SET 9

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Malta sidereal time; signals *received*			Resulting longitude, Alexandria east of Malta		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	13	53	1·0	13	32	55·66	12	31	24·83	1	1	30·83
2			12·0		33	6·66			36·56			30·10
3			21·6			16·26			45·69			30·57
4			32·3			26·97			56·61			30·36
5			41·0			35·67		32	4·94			30·73
6		54	0·9			55·57			24·79			30·78
7			11·4		34	6·07			35·82			30·25
8			21·7			16·37			46·05			30·32
9			31·4			26·07			56·68			[29·39*]
10			41·4			36·07		33	5·00			31·07
11		55	1·0			55·67			24·97			30·70
12			11·7		35	6·37			35·20			31·17
13			21·8			16·47			45·93			30·54
14		56	1·7			56·37		34	26·03			30·34
15			12·8		36	7·47			37·16			30·31
16			23·0			17·67			47·09			30·58
17			31·6			26·27			55·72			30·55
18			43·6			38·27		35	7·15			31·12
19		57	1·7			56·37			26·10			30·27
20			12·6		37	7·27			36·33			30·94
21			32·0			26·67			56·38			30·29
22			43·0			37·67		36	7·41			30·26
23		58	1·8			56·47			25·86			30·61
24			12·2		38	6·87			36·49			30·38
25			23·1			17·77			47·52			30·25
26			32·0			26·68			56·55			30·13
27	13	58	42·0	13	38	36·68	12	37	6·57			30·11

[*] Discordant; rejected.

1875, MARCH 12 (*continued*)

SET 10

Number of signal	Time by chronometer 43			Alexandria sidereal time ; signals *received*			Corresponding Malta sidereal time ; signals *sent*			Resulting longitude, Alexandria east of Malta		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	14	13	21·1	13	53	15·80	12	51	44·98	1	1	30·82
2			33·3			28·00			55·81			[32·29*]
3			51·1			45·81		52	14·96			30·85
4		14	1·2			55·91			24·99			30·92
5			22·2		54	16·91			46·15			30·76
6			31·8			26·51			55·37			31·14
7			42·1			36·81		53	6·20			30·61
8			51·1			45·81			15·03			30·78
9		15	2·2			56·91			26·26			30·65
10			32·3		55	27·01			56·34			30·67
11			42·0			36·71		54	5·36			31·35
12			52·3			47·01			16·39			30·62
13		16	1·8			56·51			25·42			31·09
14			22·4		56	17·11			45·97			31·14
15			32·3			27·01			56·50			30·51
16			42·0			36·71		55	5·53			31·18
17			52·3			47·01			16·46			30·55
18		17	1·4			56·11			25·58			30·53
19			22·1		57	16·81			45·64			31·17
20			32·3			27·01			55·97			31·04
21			43·0			37·71		56	6·80			30·91
22	14	17	52·1	13	57	46·81	12	56	15·72			31·09

SET 11

Number of signal	Time by chronometer 43			Alexandria sidereal time ; signals *received*			Corresponding Malta sidereal time ; signals *sent*			Resulting longitude, Alexandria east of Malta		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	14	20	23·0	14	0	17·72	12	58	46·93	1	1	30·79
2			33·2			27·92			57·16			30·76
3			42·8			37·52		59	6·19			31·33
4			52·8			47·52			16·21			31·31
5		21	3·0			57·72			26·64			31·08
6			22·4		1	17·12			46·40			30·72
7			33·3			28·02			57·02			31·00
8			43·0			37·72	13	0	6·65			31·07
9			53·1			47·82			16·38			31·44
10		22	3·2			57·92			26·61			31·31
11			23·3		2	18·02			47·46			30·56
12			33·7			28·42			57·49			30·93
13			43·0			37·72		1	6·52			31·20
14			52·6			47·32			16·44			30·88
15		23	3·3			58·02			27·37			30·65
16			23·0		3	17·72			46·62			31·10
17			33·3			28·02			57·65			30·37
18			42·4			37·12		2	6·58			30·54
19			53·7			48·42			16·51			[31·91*]
20		24	23·7		4	18·43			47·59			30·84
21			33·0			27·73			56·82			30·91
22			43·9			38·63		3	7·75			30·88
23			53·4			48·13			17·37			30·76
24		25	3·8			58·53			27·90			30·63
25			23·1		5	17·83			46·75			31·08
26			43·1			37·83		4	7·01			30·82
27			53·4			48·13			17·04			31·09
28		26	4·0			58·73			27·56			31·17
29			23·7		6	18·43			47·82			30·61
30			34·1			28·83			58·15			30·68
31			43·2			37·93		5	7·07			30·86
32			54·1			48·83			18·00			30·83
33	14	27	4·1	14	6	58·83	13	5	28·03			30·80

[*] Discordant ; rejected.

1875, March 12 (*continued*)

Set 12

Number of signal	Time by chronometer 43	Alexandria sidereal time; signals *received*	Corresponding Malta sidereal time; signals *sent*	Resulting longitude, Alexandria east of Malta
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 48 26·3	14 28 21·07	13 26 50·65	1 1 30·42
2	47·9	42·67	27 11·71	30·96
3	57·0	51·77	20·83	30·94
4	49 7·9	29 2·67	31·16	31·51
5	28·0	22·78	51·92	30·86
6	47·1	41·88	28 11·07	30·81
7	58·1	52·88	21·80	31·08
8	50 7·2	30 1·98	31·43	30·55
9	28·1	22·88	51·88	31·00
10	38·0	32·78	29 2·01	30·77
11	48·0	42·78	12·14	30·64
12	51 8·0	31 2·78	31·99	30·79
13	27·1	21·88	51·04	30·84
14	38·1	32·88	30 2·07	30·81
15	57·2	51·98	21·33	30·65
16	52 8·2	32 2·98	32·15	30·83
17	28·1	22·88	52·21	30·67
18	39·0	33·78	31 2·44	31·34
19	48·3	43·08	12·26	30·82
20	53 37·8	33 32·58	32 1·60	30·98
21	48·1	42·88	11·73	31·15
22	58·3	53·08	22·16	30·92
23	14 54 8·2	14 34 2·98	13 32 32·58	30·40

1875, March 14

Set 13

Number of signal	Time by chronometer 43	Alexandria sidereal time; signals *sent*	Corresponding Malta sidereal time; signals *received*	Resulting longitude, Alexandria east of Malta
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	13 40 42·1	13 20 40·95	12 19 10·11	1 1 30·84
2	52·0	50·85	21·14	29·71
3	41 2·0	21 0·85	30·17	30·68
4	10·7	9·55	39·99	29·56
5	31·9	30·75	20 0·15	30·60
6	42·6	41·45	10·98	30·47
7	52·1	50·95	20·90	30·05
8	42 2·0	22 0·85	30·13	30·72
9	12·8	11·65	41·16	30·49
10	22·0	20·85	50·18	30·67
11	32·1	30·95	21 0·21	30·74
12	42·0	40·85	10·24	30·61
13	52·0	50·85	20·27	30·58
14	13 43 3·0	13 23 1·85	12 21 31·30	30·55

1875, MARCH 14 (*continued*)

SET 13 (*continued*)

Number of signal	Time by chronometer 43	Alexandria sidereal time; signals *sent*	Corresponding Malta sidereal time; signals *received*	Resulting longitude, Alexandria east of Malta
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
15	13 43 12·2	13 23 11·05	12 21 40·53	1 1 30·52
16	22·2	21·06	50·66	30·40
17	52·8	51·66	22 21·04	30·62
18	44 2·7	24 1·56	30·57	30·99
19	12·4	11·26	40·69	30·57
20	22·6	21·46	50·52	30·94
21	52·4	51·26	23 20·61	30·65
22	45 2·8	25 1·66	31·43	30·23
23	13·0	11·86	41·66	30·20
24	23·0	21·86	51·19	30·67
25	53·1	51·96	24 21·57	30·39
26	46 2·8	26 1·66	30·80	30·86
27	23·0	21·86	51·35	30·51
28	52·7	51·56	25 20·93	30·63
29	47 2·9	27 1·76	30·96	30·80
30	13·2	12·06	41·89	30·17
31	23·3	22·16	51·92	30·24
32	53·3	52·16	26 21·60	30·56
33	48 3·4	28 2·26	32·03	30·23
34	13·3	12·17	41·95	30·22
35	23·3	22·17	51·68	30·49
36	53·6	52·47	27 21·76	30·71
37	49 4·1	29 2·97	32·39	30·58
38	14·0	12·87	42·52	30·35
39	23·6	22·47	51·44	31·03
40	43·1	41·97	28 11·60	30·37
41	54·2	53·07	22·43	30·64
42	50 24·0	30 22·87	52·51	30·36
43	43·6	42·47	29 11·76	30·71
44	51 4·3	31 3·17	32·72	30·45
45	23·9	22·77	52·67	30·10
46	44·0	42·87	30 12·63	30·24
47	54·0	52·87	22·76	30·11
48	52 3·7	32 2·57	31·78	30·79
49	14·1	12·97	42·81	30·16
50	24·6	23·47	52·84	30·63
51	13 52 43·8	13 32 42·67	12 31 11·99	30·68

1875, MARCH 14 (*continued*)

SET 14

Number of signal	Time by chronometer 43			Alexandria sidereal time ; signals *received*			Corresponding Malta sidereal time ; signals *sent*			Resulting longitude, Alexandria east of Malta		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	13	56	11·2	13	36	10·08	12	34	39·37	1	1	30·71
2			21·2			20·08			49·60			30·48
3			30·8			29·68			58·52			31·16
4			41·0			39·88		35	8·65			31·23
5			51·1			49·98			19·08			30·90
6		57	11·3		37	10·18			39·43			30·75
7			22·0			20·88			50·16			30·72
8			31·0			29·88			58·69			31·19
9			40·2			39·08		36	8·71			30·37
10			51·6			50·49			19·54			30·95
11		58	11·7		38	10·59			39·50			31·09
12			21·0			19·89			48·82			31·07
13			31·8			30·69			59·75			30·94
14		59	31·3		39	30·19		37	59·72			30·47
15			40·9			39·79		38	9·04			30·75
16			51·8			50·69			19·57			31·12
17	14	0	11·9		40	10·79			39·93			30·86
18			22·0			20·89			50·05			30·84
19			32·1			30·99			59·68			31·31
20			41·7			40·59		39	9·21			31·38
21			51·0			49·89			19·23			30·66
22		1	12·0		41	10·89			40·29			30·60
23			21·6			19·49			40·42			30·07
24			31·8			30·69		40	0·05			30·64
25			41·4			40·29			9·37			30·92
26		2	21·7		42	20·59			49·48			31·11
27			32·2			31·09		41	0·31			30·78
28			41·2			40·10			9·54			30·56
29			52·3			51·20			20·06			31·14
30		3	21·9		43	20·80			49·95			30·85
31			31·1			30·00			59·67			30·33
32			41·8			40·70		42	9·80			30·90
33			52·4			51·30			20·33			30·97
34		4	12·5		44	11·40			40·68			30·72
35			22·1			21·00			49·81			31·19
36			31·8			30·70			59·84			30·86
37			52·8			51·70		43	20·39			31·31
38		5	13·0		45	11·90			41·15			30·75
39			33·0			31·90		44	0·50			31·40
40	14	5	43·5	13	45	42·40	12	44	10·03			[32·37*]

[*] Discordant ; rejected.

1875, MARCH 14 (*continued*)

SET 15

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Malta sidereal time; signals *sent*			Resulting longitude, Alexandria east of Malta		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	14	5	52·8	13	45	51·70	12	44	20·06	1	1	31·64
2		6	11·8		46	10·70			40·11			30·59
3			23·0			21·90			50·64			31·26
4			32·0			30·90		45	0·16			30·74
5			53·0			51·90			20·72			31·18
6		7	13·0		47	11·90			40·98			30·92
7			22·6			21·50			50·40			31·10
8			42·8			41·71		46	10·36			31·35
9			52·7			51·61			20·48			31·13
10		8	13·6		48	12·51			41·44			31·07
11			23·0			21·91			50·47			31·44
12			33·2			32·11		47	1·19			30·92
13			42·8			41·71			10·52			31·19
14			52·9			51·81			20·56			31·25
15		9	12·9		49	11·81			41·61			30·20
16			23·0			21·91			51·04			30·87
17			32·9			31·81		48	0·67			31·14
18			43·9			42·81			10·70			[32·11*]
19			53·8			52·71			21·72			30·99
20		10	12·8		50	11·71			40·68			31·03
21			33·6			32·51		49	1·63			30·88
22			53·1			52·01			20·69			31·32
23		11	13·7		51	12·61			41·44			31·17
24			27·0			25·91			51·07			[34·84*]
25			43·2			42·11		50	11·02			31·09
26		12	14·0		52	12·91			41·61			31·30
27			43·3			42·22		51	11·19			31·03
28			54·0			52·92			21·72			31·20
29		13	14·1		53	13·02			41·57			31·45
30			24·0			22·92			52·10			30·82
31			33·9			32·82		52	1·53			31·29
32			43·0			41·92			11·25			30·67
33			53·9			52·82			21·48			31·34
34		14	14·0		54	12·92			42·14			30·78
35			23·9			22·82			51·46			31·36
36			33·1			32·02		53	1·39			30·63
37			43·8			42·72			11·72			31·00
38		15	14·5		55	13·42			42·80			30·62
39			34·0			32·92		54	1·65			31·27
40			43·7			42·62			11·68			30·94
41	14	15	53·9	13	55	52·82	12	54	21·91			30·91

[*] Discordant; rejected.

1875, MARCH 14 (*continued*)

SET 16

Number of signal	Time by chronometer 43	Alexandria sidereal time; signals *sent*	Corresponding Malta sidereal time; signals *received*	Resulting longitude, Alexandria east of Malta
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 20 18·4	14 0 17·33	12 58 47·23	1 1 30·10
2	28·5	27·43	57·16	30·27
3	48·2	47·13	59 16·51	30·62
4	58·9	57·83	27·34	30·49
5	21 8·3	1 7·23	36·57	30·66
6	18·9	17·83	47·50	30·33
7	28·7	27·63	57·52	30·11
8	59·0	57·94	13 0 27·62	30·32
9	22 8·6	2 7·54	36·74	30·80
10	18·9	17·84	47·67	30·17
11	49·0	47·94	1 17·35	30·59
12	23 18·8	3 17·74	46·93	30·81
13	48·7	47·64	2 17·02	30·62
14	59·7	58·64	28·05	30·59
15	24 9·8	4 8·74	38·07	30·67
16	19·0	17·94	47·30	30·64
17	28·7	27·64	57·13	30·51
18	49·0	47·94	3 17·18	30·76
19	59·5	58·44	27·71	30·73
20	25 9·1	5 8·04	38·04	30·00
21	19·0	17·94	47·26	30·68
22	29·7	28·64	57·79	30·85
23	49·2	48·14	4 17·55	30·59
24	59·8	58·74	28·17	30·57
25	26 9·7	6 8·64	38·30	30·34
26	19·3	18·24	47·43	30·81
27	30·0	28·94	58·46	30·48
28	49·6	48·55	5 18·31	30·24
29	59·4	58·35	28·04	30·31
30	27 9·6	7 8·55	38·06	30·49
31	19·1	18·05	47·59	30·46
32	29·1	28·05	57·92	30·13
33	49·8	48·75	6 17·77	30·98
34	59·3	58·25	27·90	30·35
35	14 28 9·3	14 8 8·25	13 6 38·23	30·02

Taking the means of the results of the foregoing sets, we obtain—

Difference of longitude by signals sent from Alexandria and recorded at Malta.

Date	Set	Number of signals	Resulting longitude, Alexandria east of Malta h. m. s.	h. m. s.
1875, March 10	1	39	1 1 30·434	1 1 30·398
,, ,,	4	37	30·363	
,, March 11	5	39	1 1 30·634	1 1 30·530
,, ,,	8	33	30·425	
,, March 12	9	26	1 1 30·522	1 1 30·522
,, March 14	13	51	1 1 30·492	1 1 30·490
,, ,,	16	35	30·488	

Difference of longitude by signals sent from Malta and recorded at Alexandria.

Date	Set	Number of signals	Resulting longitude, Alexandria east of Malta h. m. s.	h. m. s.
1875, March 10	2	38	1 1 30·818	1 1 30·791
,, ,,	3	26	30·764	
,, March 11	6	32	1 1 31·002	1 1 31·000
,, ,,	7	27	30·998	
,, March 12	10	21	1 1 30·875	
,, ,,	11	32	30·906	1 1 30·880
,, ,,	12	23	30·858	
,, March 14	14	39	1 1 30·873	1 1 30·963
,, ,,	15	39	31·053	

Combining these results on the supposition that the current time is the same in both directions, we have—

		h. m. s.		s.
March 10	Alexandria east of Malta	1 1 30·595	Current time	0·196
March 11	,, ,,	30·765	,,	0·235
March 12	,, ,,	30·701	,,	0·179
March 14	,, ,,	30·726	,,	0·236

There being only one set of signals sent from Alexandria to Malta on March 12, half weight is given both to the longitude and current time results of that day; and the time determinations being less complete on March 14 than on the other days, the resulting longitude for that day also receives half weight. We thus obtain—

	h. m. s.
Alexandria east of Malta	1 1 30·69
Correction for personal equation between Dr. Löw and Mr. Gill * { in observing transits	−0·06
Correction for personal equation between Dr. Löw and Mr. Gill * { in recording signals	+0·02

Therefore we finally get—

	h. m. s.
Alexandria east of Malta	1 1 30·65

and—

Current time . . . . . 0ˢ·216

* Details of these determinations will be found on pp. 249 and 349 respectively.

The following table shows both the chronometer and local sidereal times of despatch and receipt of signals at Alexandria when exchanging signals with Berlin. Then, in order to deduce immediately the difference of longitude, the Berlin sidereal times of receipt and despatch of corresponding signals at that end of the line have been added. The last column in each set thus contains the apparent difference of meridians.

ALEXANDRIA-BERLIN LONGITUDE.

1875, FEBRUARY 28

SET 1 (*made* signals)

Number of signal	Time by chronometer 36	Alexandria sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Alexandria east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 5 20·0	14 27 31·02	13 21 32·72	1 5 58·30
2	30·2	41·25	43·02	58·23
3	40·3	51·38	53·21	58·17
4	50·3	28 1·40	22 3·21	58·19
5	6 10·4	21·56	23·21	58·35
6	20·0	31·18	32·90	58·28
7	30·0	41·21	42·90	58·31
8	40·0	51·24	53·00	58·24
9	7 10·4	29 21·72	23 23·29	58·43
10	40·0	51·40	53·18	58·22
11	50·4	30 1·83	24 3·48	58·35
12	8 10·0	21·49	22·98	58·51
13	20·2	31·71	33·47	58·24
14	30·3	41·84	43·57	58·27
15	40·5	52·07	53·67	58·40
16	50·4	31 2·00	25 3·57	58·43
17	9 10·4	22·05	23·66	58·39
18	20·0	31·68	33·26	58·42
19	40·3	52·03	53·75	58·28
20	14 9 50·0	14 32 1·76	13 26 3·55	58·21

SET 2 (*made* signals)

Number of signal	Time by chronometer 36	Alexandria sidereal time; signals *received*	Corresponding Berlin sidereal time; signals *sent*	Resulting longitude, Alexandria east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 10 59·7	14 33 11·65	13 27 11·13	1 6 0·52
2	11 19·7	31·70	31·13	0·57
3	39·6	51·66	51·12	0·54
4	49·6	34 1·69	28 1·12	0·57
5	59·6	11·71	11·12	0·59
6	12 19·5	31·67	31·11	0·56
7	29·5	41·70	41·11	0·59
8	39·4	51·62	51·11	0·51
9	49·4	35 1·65	29 1·11	0·54
10	59·3	11·58	11·10	0·48
11	13 19·2	31·53	31·10	0·43
12	29·1	41·46	41·10	0·36
13	39·1	51·49	51·09	0·40
14	49·1	36 1·51	30 1·09	0·42
15	59·1	11·54	11·09	0·45
16	14 19·0	31·50	31·08	0·42
17	39·1	51·64	51·08	0·56
18	59·0	37 11·60	31 11·07	0·53
19	15 9·0	21·62	21·07	0·55
20	19·0	31·65	31·07	0·58
21	28·9	41·58	41·07	0·51
22	38·9	51·60	51·06	0·54
23	14 15 48·9	14 38 1·63	13 32 1·06	0·57

1875, FEBRUARY 28 (*continued*)

SET 3 (*broken* signals)

Number of signal	Time by chronometer 36	Alexandria sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Alexandria east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 28 20·3	14 50 35·08	13 44 36·87	1 5 58·21
2	29 10·2	51 25·11	45 27·05	58·06
3	20·0	34·94	36·95	57·99
4	40·0	55·00	57·15	57·85
5	50·0	52 5·02	46 6·84	58·18
6	30 10·1	25·18	27·34	57·84
7	20·0	35·11	37·34	57·77
8	30·2	45·33	47·33	58·00
9	40·0	55·16	57·23	57·93
10	50·0	53 5·19	47 7·13	58·06
11	31 20·0	35·27	37·42	57·85
12	30·0	45·30	47·32	57·98
13	40·0	55·33	57·31	58·02
14	50·0	54 5·35	48 7·51	57·84
15	32 10·1	25·51	27·41	58·10
16	29·9	45·36	47·40	57·96
17	40·2	55·69	58·30	[57·39*]
18	50·0	55 5·52	49 7·40	58·12
19	33 20·2	35·80	37·79	58·01
20	30·0	45·63	47·58	58·05
21	40·1	55·75	57·78	57·97
22	14 33 49·9	14 56 5·58	13 50 7·58	58·00

SET 4 (*broken* signals)

Number of signal	Time by chronometer 36	Alexandria sidereal time; signals *received*	Corresponding Berlin sidereal time; signals *sent*	Resulting longitude, Alexandria east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 36 21·6	14 58 37·69	14 52 40·74	[1 5 56·95*]
2	34·5	50·62	50·74	1 5 59·88
3	44·5	59 0·65	53 0·73	59·92
4	54·4	10·58	10·73	59·85
5	37 24·3	40·56	40·72	59·84
6	33·9	50·19	50·72	59·47
7	44·1	15 0 0·41	54 0·72	59·69
8	54·0	10·34	10·72	59·62
9	38 14·1	30·50	30·71	59·79
10	23·9	40·32	40·71	59·61
11	34·0	50·45	50·71	59·74
12	43·0	59·47	55 0·70	[58·77*]
13	53·9	1 10·40	10·70	59·70
14	39 13·8	30·36	30·69	59·67
15	23·8	40·39	40·69	59·70
16	33·7	50·31	50·69	59·62
17	40 13·8	2 30·52	56 30·68	59·84
18	33·7	50·48	50·67	59·81
19	14 40 43·6	15 3 0·40	14 57 0·67	59·73

[*] Discordant; rejected.

1875, FEBRUARY 28 (*continued*)

SET 5 (*broken* signals)

Number of signal	Time by chronometer 36	Alexandria sidereal time ; signals *sent*	Corresponding Berlin sidereal time ; signals *received*	Resulting longitude, Alexandria east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 42 10·0	15 4 27·04	13 58 29·15	1 5 57·89
2	20·0	37·07	39·15	57·92
3	30·0	47·09	48·84	58·25
4	40·0	57·12	59·14	57·98
5	50·0	5 7·15	59 9·14	58·01
6	43 10·0	27·20	29·13	58·07
7	20·0	37·23	39·13	58·10
8	30·0	47·26	49·13	58·13
9	50·0	6 7·31	14 0 9·22	58·09
10	44 10·0	27·37	29·32	58·05
11	20·0	37·40	39·21	58·19
12	30·0	47·42	49·21	58·21
13	50·1	7 7·58	1 9·41	58·17
14	45 10·0	27·52	29·60	57·92
15	20·0	37·55	39·60	57·95
16	30·0	47·58	49·40	58·18
17	40·0	57·61	59·59	58·02
18	49·9	8 7·53	2 9·69	57·84
19	46 9·9	27·59	29·69	57·90
20	20·0	37·71	39·68	58·03
21	30·0	47·74	49·88	57·86
22	14 46 40·0	15 8 57·77	14 3 0·58	[57·19*]

SET 6 (*broken* signals)

Number of signal	Time by chronometer 36	Alexandria sidereal time ; signals *received*	Corresponding Berlin sidereal time ; signals *sent*	Resulting longitude, Alexandria east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 48 32·2	15 10 50·28	14 4 50·55	1 5 59·73
2	42·2	11 0·30	5 0·55	59·75
3	52·1	10·23	10·54	59·69
4	49 12·1	30·29	30·54	59·75
5	31·9	50·14	50·53	59·61
6	42·0	12 0·27	6 0·53	59·74
7	52·0	10·30	10·53	59·77
8	50 11·9	30·25	30·52	59·73
9	21·8	40·18	40·52	59·66
10	31·7	50·10	50·52	59·58
11	41·8	13 0·23	7 0·51	59·72
12	51·7	10·16	10·51	59·65
13	51 11·8	30·31	30·51	59·80
14	21·8	40·34	40·50	59·84
15	31·7	50·27	50·50	59·77
16	41·6	14 0·20	8 0·50	59·70
17	51·5	10·12	10·50	59·62
18	52 11·4	30·08	30·49	59·59
19	21·4	40·10	40·49	59·61
20	31·3	50·03	50·49	59·54
21	41·3	15 0·06	9 0·48	59·58
22	51·3	10·09	10·48	59·61
23	14 53 11·4	15 15 30·24	14 9 30·48	59·76

[*] Discordant ; rejected.

1875, FEBRUARY 28 (*continued*)

SET 7 (*made* signals)

Number of signal	Time by chronometer 36			Alexandria sidereal time; signals *received*			Corresponding Berlin sidereal time; signals *sent*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	15	8	49·4	15	31	10·79	14	25	10·21	1	6	0·58
2		9	9·4			30·84			30·20			0·64
3			19·2			40·67			40·20			0·47
4			29·1			50·60			50·20			0·40
5			39·1		32	0·62		26	0·20			0·42
6		10	9·1			30·71			30·19			0·52
7			28·9			50·56			50·18			0·38
8			39·9		33	1·59		27	0·18			[1·41*]
9			49·9			11·62			10·17			[1·45*]
10		11	8·9			30·67			30·17			0·50
11			18·9			40·70			40·17			0·53
12			28·7			50·53			50·16			0·37
13			38·8		34	0·65		28	0·16			0·49
14			48·7			10·58			10·16			0·42
15		12	8·7			30·63			30·15			0·48
16			18·6			40·56			40·15			0·41
17			28·6			50·59			50·15			0·44
18			38·6		35	0·62		29	0·14			0·48
19			48·5			10·54			10·14			0·40
20		13	8·4			30·50			30·13			0·37
21			18·5			40·63			40·13			0·50
22			28·4			50·55			50·13			0·42
23	15	13	38·4	15	36	0·58	14	30	0·12			0·46

SET 8 (*made* signals)

Number of signal	Time by chronometer 36			Alexandria sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	15	15	10·0	15	37	32·43	14	31	34·10	1	5	58·33
2			20·0			42·46			44·19			58·27
3			30·0			52·48			54·19			58·29
4			40·0		38	2·50		32	4·09			58·41
5			50·0			12·53			14·08			58·45
6		16	10·0			32·59			34·28			58·31
7			20·0			42·61			44·28			58·33
8			30·0			52·64			54·27			58·37
9			40·0		39	2·67		33	4·37			58·30
10			50·0			12·70			14·37			58·33
11		17	10·0			32·75			34·56			58·19
12			20·0			42·78			44·46			58·32
13			30·0			52·80			54·35			58·45
14			40·0		40	2·83		34	4·45			58·38
15			50·0			12·86			14·55			58·31
16		18	10·0			32·91			34·54			58·37
17			20·0			42·94			44·54			58·40
18			30·0			52·97			54·54			58·43
19			40·0		41	3·00		35	4·68			58·32
20			50·0			13·02			14·63			58·39
21		19	10·0			33·08			34·52			58·56
22			20·0			43·11			44·72			58·39
23			30·0			53·13			54·77			58·36
24			40·0		42	3·16		36	4·82			58·34
25			50·0			13·19			14·81			58·38
26		20	10·0			33·24			35·01			58·23
27			20·0			43·27			44·80			58·47
28			30·0			53·30			54·90			58·40
29			40·0		43	3·32		37	5·00			58·32
30	15	20	50·0	15	43	13·35	14	37	14·99			58·36

[*] Discordant; rejected.

1875, FEBRUARY 28 (*continued*)

SET 8 (*made* signals)—*continued*

Number of signal	Time by chronometer 36			Alexandria sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m	s.
31	15	21	9·9	15	43	33·31	14	37	34·99	1	5	58·32
32			20·0			43·43			45·09			58·34
33			30·0			53·46			55·18			58·28
34			40·0		44	3·49		38	5·08			58·41
35			50·0			13·52			15·13			58·39
36		22	9·5			33·07			34·47			58·60
37			20·0			43·60			45·27			58·33
38			30·0			53·63			55·27			58·36
39			40·2		45	3·85		39	5·46			58·39
40			50·0			13·68			15·26			58·42
41		23	10·0			33·74			35·25			58·49
42			20·0			43·76			45·35			58·41
43			30·0			53·79			55·35			58·44
44			40·0		46	3·82		40	5·44			58·38
45			50·0			13·84			15·44			58·40
46		24	10·0			33·90			35·44			58·46
47			20·0			43·93			45·43			58·50
48			30·0			53·95			55·58			58·37
49			40·0		47	3·98		41	5·53			58·45
50	15	24	50·0	15	47	14·01	14	41	15·62			58·39

1875, MARCH 6

SET 9 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	13	27	50·0	13	7	33·72	12	1	35·65	1	5	58·07
2		28	10·0			53·72			55·60			58·12
3			20·0		8	3·72		2	5·63			58·09
4			30·0			13·72			15·66			58·06
5			40·0			23·72			25·58			58·14
6			50·0			33·72			35·61			58·11
7		29	10·0			53·72			55·57			58·15
8			20·0		9	3·72		3	5·59			58·13
9			30·0			13·72			15·62			58·10
10			40·0			23·72			25·55			58·17
11			50·0			33·72			35·48			58·24
12		30	10·0			53·72			55·53			58·19
13			20·0		10	3·72		4	5·66			58·06
14			30·0			13·72			15·59			58·13
15			40·0			23·72			25·61			58·11
16			50·0			33·72			35·64			58·08
17		31	10·0			53·72			55·69			58·03
18			20·0		11	3·72		5	5·62			58·10
19			30·0			13·72			15·60			58·12
20			50·0			33·72			35·50			58·22
21		32	10·0			53·72			55·46			58·26
22			20·0		12	3·72		6	5·64			58·08
23			30·0			13·72			15·51			58·21
24			40·0			23·72			25·54			58·18
25			50·0			33·72			35·58			58·14
26		33	10·0			53·72			55·63			58·09
27			20·0		13	3·72		7	5·66			58·06
28			30·0			13·72			15·69			58·03
29			40·0			23·72			25·61			58·11
30	13	33	50·0	13	13	33·72	12	7	35·64			58·08

1875, MARCH 6 (*continued*)

SET 10 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Berlin sidereal time; signals *sent*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	13	34	46·0	13	14	29·73	12	8	29·79	1	5	59·94
2			56·1			39·83			39·82	1	6	0·01
3		35	6·2			49·93			49·84			0·09
4			16·2			59·93			59·87			0·06
5			36·3		15	20·03		9	19·93			0·10
6			46·3			30·03			29·95			0·08
7			56·3			40·03			39·98			0·05
8		36	6·3			50·03			50·01			0·02
9			16·4		16	0·13		10	0·04			0·09
10			36·6			20·33			20·09			0·24
11			56·6			40·33			40·15			0·18
12		37	6·7			50·43			50·17			0·26
13			16·6		17	0·33		11	0·20			0·13
14			27·7			11·43			11·23			0·20
15			36·7			20·43			20·26			0·17
16			46·7			30·43			30·28			0·15
17			56·8			40·53			40·31			0·22
18		38	6·7			50·43			50·34			0·09
19			16·8		18	0·53		12	0·36			0·17
20			27·8			11·53			11·40			0·13
21			36·9			20·63			20·43			0·20
22			46·9			30·63			30·46			0·17
23			56·9			40·63			40·48			0·15
24		39	6·9			50·63			50·51			0·12
25			16·9		19	0·63		13	0·54			0·09
26			28·0			11·73			11·57			0·16
27			37·0			20·73			20·59			0·14
28			47·0			30·73			30·62			0·11
29			57·1			40·83			40·65			0·18
30		40	7·1			50·83			50·68			0·15
31			17·1		20	0·83		14	0·70			0·13
32			28·2			11·93			11·73			0·20
33			37·1			20·83			20·76			0·07
34			47·2			30·93			30·79			0·14
35			57·2			40·93			40·81			0·12
36	13	41	7·2	13	20	50·93	12	14	50·84			0·09

SET 11 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m	s.	h.	m.	s.	h.	m.	s.
1	13	42	20·0	13	22	3·73	12	16	5·54	1	5	58·19
2			30·0			13·73			15·67			58·06
3			50·0			33·73			35·63			58·10
4		43	1·0			44·73			46·66			58·07
5			10·0			53·73			55·68			58·05
6			20·0		23	3·73		17	5·71			58·02
7			30·0			13·73			15·69			58·04
8			40·0			23·73			25·66			58·07
9		44	1·0			44·74			46·73			58·01
10			20·0		24	3·74		18	5·63			58·11
11			30·0			13·74			15·51			58·23
12			40·0			23·74			25·59			58·15
13			50·0			33·74			35·56			58·18
14		45	1·0			44·74			46·59			58·15
15			10·0			53·74			55·52			58·22
16			30·0		25	13·74		19	15·62			58·12
17	13	45	40·0	13	25	23·74	12	19	25·70			58·04

1875, MARCH 6 (*continued*)

SET 11 (*made* signals)—*continued*

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
18	13	45	50·0	13	25	33·74	12	19	35·68	1	5	58·06
19		46	1·0			44·74			46·66			58·08
20			10·0			53·74			55·68			58·06
21			20·0		26	3·74		20	5·61			58·13
22			30·0			13·74			15·64			58·10
23			40·0			23·74			25·61			58·13
24			50·0			33·74			35·59			58·15
25		47	1·0			44·74			46·52			58·22
26			10·0			53·74			55·65			58·09
27			20·0		27	3·74		21	5·67			58·07
28			30·0			13·74			15·60			58·14
29			40·0			23·74			25·83			57·91
30			50·0			33·74			35·86			57·88
31		48	1·0			44·74			45·68			[59·06*]
32			10·0			53·74			55·61			58·13
33			20·0		28	3·74		22	5·54			58·20
34			30·0			13·74			15·61			58·13
35			40·0			23·74			25·59			58·15
36	13	48	50·0	13	28	33·74	12	22	35·62			58·12

SET 12 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Berlin sidereal time; signals *sent*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	13	49	58·8	13	29	42·54	12	23	42·31	1	6	0·23
2		50	8·7			52·44			52·34			0·10
3			18·7		30	2·44		24	2·37			0·07
4			29·8			13·54			13·40			0·14
5			38·8			22·54			22·42			0·12
6			48·8			32·54			32·45			0·09
7			58·8			42·54			42·48			0·06
8		51	8·9			52·64			52·50			0·14
9			18·9		31	2·64		25	2·53			0·11
10			29·9			13·64			13·56			0·08
11			39·0			22·74			22·58			0·16
12			49·0			32·74			32·61			0·13
13			59·0			42·74			42·64			0·10
14		52	19·1		32	2·84		26	2·69			0·15
15			30·1			13·84			13·72			0·12
16			39·1			22·84			22·75			0·09
17			49·1			32·84			32·78			0·06
18			59·1			42·84			42·80			0·04
19		53	9·2			52·94			52·83			0·11
20			19·2		33	2·94		27	2·86			0·08
21			30·2			13·94			13·89			0·05
22			39·2			22·95			22·91			0·04
23			49·4			33·15			32·94			0·21
24			59·3			43·05			42·97			0·08
25		54	9·3			53·05			53·00			0·05
26			19·3		34	3·05		28	3·02			0·03
27			30·4			14 15			14·05			0·10
28			39·4			23·15			23·08			0·07
29			49·4			33·15			33·11			0·04
30			59·5			43·25			43·13			0·12
31		55	9·5			53·25			53·17			0·08
32			19·5		35	3·25		29	3·20			0·05
33	13	55	30·6	13	35	14·35	12	29	14·23			0·12

[*] Discordant; rejected.

1875, MARCH 6 (*continued*)

SET 13 (*broken* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	14	6	10·0	13	45	53·76	12	39	55 49	1	5	58·27
2			20·0		46	3·76		40	5·83			57·93
3			30·0			13·76			15·55			58·21
4			40·0			23·76			25·58			58·18
5		7	1·0			44·76			46·64			58·12
6			10·0			53·76			55·66			58·10
7			20·0		47	3·76		41	5·64			58·12
8			30·0			13·76			15·57			58·19
9			40·0			23·76			25·54			58·22
10		8	10·0			53·76			55·83			57·93
11			20·0		48	3·76		42	5·45			58·31
12			30·0			13·76			15·68			58·08
13			40·0			23·76			25·71			58·05
14			50·0			33·76			35·53			58·23
15		9	1·0			44·76			46·77			57·99
16			10·0			53·76			55·69			58·07
17			20·0		49	3·76		43	5·52			58·24
18			30·0			13·76			15·54			58·22
19			40·0			23·76			25·57			58·19
20			50·0			33·76			35·50			58·26
21		10	1·0			44·76			46·53			58·23
22			20·0		50	3·76		44	5·58			58·18
23			30·0			13·76			15·51			58·25
24			40·0			23·76			25·84			57·92
25			50·0			33·76			35·76			58·00
26		11	1·0			44·76			46·79			57·97
27			10·0			53·76			55·62			58·14
28			20·0		51	3·76		45	5·54			58·22
29			30·0			13·76			15·57			58·19
30			40·0			23·76			25·65			58·11
31		12	10·0			53·76			55·59			58·17
32			20·0		52	3·76		46	5·57			58·19
33			30·0			13·76			15·55			58·21
34			40·0			23·76			25·62			58·14
35	14	12	50·0	13	52	33·76	12	46	35·60			58·16

SET 14 (*broken* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Berlin sidereal time; signals *sent*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	14	13	42·2	13	53	25·97	12	47	26·24	1	5	59·73
2			52·1			35·87			36·27			59·60
3		14	2·2			45·97			46·29			59·68
4			12·2			55·97			56·32			59·65
5			22·3		54	6·07		48	6·35			59·72
6			33·2			16·97			17·38			59·59
7			42·2			25·97			26·40			59·57
8			52·3			36·07			36·43			59·64
9		15	2·2			45·97			46·46			59·51
10			12·3			56·07			56·48			59·59
11			22·3		55	6·07		49	6·51			59·56
12			33·2			16·97			17·54			59·43
13			42·4			26·17			26·57			59·60
14			52·4			36·17			36·59			59·58
15		16	2·4			46·17			46·62			59·55
16			12·4			56·17			56·65			59·52
17			22·5		56	6·27		50	6·68			59·59
18			33·5			17·27			17·71			59·56
19			42·6			26·37			26·73			59·64
20	14	16	52·6	13	56	36·37	12	50	36·76			59·61

1875, MARCH 6 (*continued*)

SET 14 (*broken* signals)—*continued*

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Berlin sidereal time; signals *sent*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
21	14	17	2·7	13	56	46·47	12	50	46·79	1	5	59·68
22			12·6			56·37			56·81			59·56
23			22·7		57	6·47		51	6·85			59·62
24			33·7			17·47			17·88			59·59
25			42·8			26·57			26·91			59·66
26			52·8			36·57			36·93			59·64
27		18	2·8			46·57			46·96			59·61
28			12·9			56·67			56·99			59·68
29			22·9		58	6·67		52	7·01			59·66
30			34·1			17·87			17·04			[60·83*]
31			43·0			26·77			27·07			59·70
32			53·0			36·77			37·10			59·67
33		19	3·0			46·77			47·12			59·65
34			13·0			56·77			57·15			59·62
35			23·1		59	6·87		53	7·18			59·69
36	14	19	34·1	13	59	17·87	12	53	18·21			59·66

SET 15 (*broken* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	14	21	10·0	14	0	53·77	12	54	55·48	1	5	58·29
2			20·0		1	3·77		55	5·50			58·27
3			30·0			13·77			15·53			58·24
4			40·0			23·77			25·56			58·21
5			50·0			33·77			35·58			58·19
6		22	1·0			44·77			46·61			58·16
7			10·0			53·77			55·64			58·13
8			20·0		2	3·77		56	5·57			58·20
9			30·0			13·77			15·59			58·18
10			40·0			23·77			25·57			58·20
11			50·0			33·78			35·75			58·03
12		23	1·0			44·78			46·59			58·19
13			10·0			53·78			55·56			58·22
14			20·0			3·78		57	5·59			58·19
15			30·0			13·78			15·62			58·16
16			40·0			23·78			25·60			58·18
17			50·0			33·78			35·62			58·16
18		24	10·0			53·78			55·48			58·30
19			20·0		4	3·78		58	5·55			58·23
20			30·0			13·78			15·58			58·20
21			40·0			23·78			25·56			58·22
22			50·0			33·78			35·59			58·19
23		25	1·0			44·78			46·62			58·16
24			10·0			53·78			55·64			58·14
25			20·0		5	3·78		59	5·67			58·11
26			30·0			13·78			15·70			58·08
27			40·0			23·78			25·67			58·11
28			50·0			33·78			35·70			58·08
29		26	1·0			44·78			46·73			58·05
30			10·0			53·78			55·71			58·07
31			20·0		6	3·78	13	0	5·73			58·05
32			30·0			13·78			15·66			58·12
33			40·0			23·78			25·64			58·14
34			50·0			33·78			35·76			58·02
35		27	10·0			53·78			55·97			57·81
36			20·0		7	3·78		1	5·60			58·18
37			30·0			13·78			15·57			58·21
38			40·0			23·78			25·60			58·18
39	14	27	50·0	14	7	33·78	13	1	35·63			58·15

[*] Discordant; rejected.

1875, MARCH 6 (*continued*)

SET 16 (*broken* signals)

Number of signal	Time by chronometer 43	Alexandria sidereal time ; signals *received*	Corresponding Berlin sidereal time ; signals *sent*	Resulting longitude, Alexandria east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 28 54·6	14 8 38·38	13 2 38·76	1 5 59·62
2	29 4·7	48·48	48·79	59·69
3	14·7	58·48	58·81	59·67
4	24·8	9 8·58	3 8·84	59·74
5	35·7	19·48	19·87	59·61
6	44·8	28·58	28·90	59·68
7	54·8	38·58	38·92	59·66
8	30 4·8	48·58	48·95	59·63
9	14·9	58·68	58·98	59·70
10	36·0	10 19·78	4 20·04	59·74
11	45·0	28·78	29·06	59·72
12	54·9	38·68	39·09	59·59
13	31 5·0	48·78	49·12	59·66
14	15·0	58·78	59·14	59·64
15	25·0	11 8·78	5 9·17	59·61
16	36·1	19·88	20·20	59·68
17	45·1	28·88	29·23	59·65
18	55·2	38·98	39·25	59·73
19	32 5·2	48·98	49·28	59·70
20	15·1	58·88	59·31	59·57
21	25·2	12 8·98	6 9·34	59·64
22	36·3	20·09	20·36	59·73
23	45·2	28·99	29·39	59·60
24	55·2	38·99	39·42	59·57
25	33 5·3	49·09	49·44	59·65
26	25·3	13 9·09	7 9·50	59·59
27	36·3	20·09	20·53	59·56
28	45·4	29·19	29·55	59·64
29	55·4	39·19	39·58	59·61
30	34 5·4	49·19	49·62	59·57
31	15·6	59·39	59·65	59·74
32	25·6	14 9·39	8 9·67	59·72
33	36·5	20·29	20·70	59·59
34	55·5	39·29	39·76	59·53
35	35 5·6	49·39	49·78	59·61
36	15·7	59·49	59·81	59·68
37	14 35 25·7	14 15 9·49	13 9 9·84	59·65

1875, MARCH 7

SET 17 (*made* signals)

Number of signal	Time by chronometer 43	Alexandria sidereal time ; signals *sent*	Corresponding Berlin sidereal time ; signals *received*	Resulting longitude, Alexandria east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	13 10 20·0	12 50 5·42	11 44 7·39	1 5 58·03
2	30·0	15·42	17·22	58·20
3	40·0	25·42	27·24	58·18
4	50·0	35·42	37·17	58·25
5	11 1·0	46·42	48·10	58·32
6	10·0	55·42	57·13	58·29
7	20·0	51 5·42	45 7·10	58·32
8	30·0	15·42	17·08	58·34
9	40·0	25·42	27·11	58·31
10	50·0	35·42	37·14	58·28
11	12 1·0	46·42	48·17	58·25
12	10·0	55·42	57·14	58·28
13	20·0	52 5·42	46 7·12	58·30
14	30·0	15·42	17·14	58·28
15	40·0	25·42	27·12	58·30
16	50·0	35·42	37·05	58·37
17	13 13 20·0	12 53 5·42	11 47 7·08	58·34

1875, MARCH 7 (*continued*)

SET 17 (*made* signals)—*continued*

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
18	13	13	30·0	12	53	15·42	11	47	17·11	1	5	58·31
19			40·0			25·42			27·14			58·28
20			50·0			35·42			37·06			58·36
21		14	1·0			46·42			48·14			58·28
22			10·0			55·42			57·07			58·35
23			20·0		54	5·42		48	7·04			58·38
24			40·0			25·42			27·10			58·32
25			50·0			35·42			37·13			58·29
26		15	0·0			45·42			47·15			58·27
27			10·0			55·42			57·19			58·23
28			20·0		55	5·42		49	7·12			58·30
29			30·0			15·42			17·10			58·32
30			40·0			25·42			27·12			58·30
31			50·0			35·42			37·05			58·37
32		16	1·0			46·42			48·08			58·34
33			20·0		56	5·42		50	6·98			58·44
34			30·0			15·42			17·21			58·21
35			40·0			25·42			27·24			58·18
36			50·0			35·42			37·06			58·36
37	13	17	1·0	12	56	46·43	11	50	48·09			58·34

SET 18 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Berlin sidereal time; signals *sent*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	13	17	49·0	12	57	34·43	11	51	34·12	1	6	0·31
2			59·1			44·53			44·15			0·38
3		18	9·1			54·53			54·17			0·36
4			20·2		58	5·63		52	5·20			0·43
5			29·3			14·73			14·23			0·50
6			39·3			24·73			24·26			0·47
7			49·4			34·83			34·28			0·55
8		19	9·4			54·83			54·34			0·49
9			20·6		59	6·03		53	5·37			0·66
10			39·6			25·03			24·42			0·61
11			49·6			35·03			34·45			0·58
12			59·7			45·13			44·48			0·65
13		20	9·7			55·13			54·51			0·62
14			20·7	13	0	6·13		54	5·54			0·59
15			29·8			15·23			14·57			0·66
16			39·8			25·23			24·60			0·63
17			49·7			35·13			34·62			0·51
18			59·8			45·23			44·65			0·58
19		21	9·8			55·23			54·68			0·55
20			20·9		1	6·33		55	5·71			0·62
21			29·9			15·33			14·73			0·60
22			50·0			35·43			34·79			0·64
23		22	0·0			45·43			44·81			0·62
24			10·0			55·43			54·84			0·59
25			30·0		2	15·43		56	14·90			0·53
26			40·1			25·53			24·92			0·61
27			50·1			35·53			34·95			0·58
28		23	0·2			45·63			44·98			0·65
29			10·2			55·63			55·01			0·62
30			21·2		3	6·63		57	6·04			0·59
31			30·1			15·53			15·06			0·47
32			40·2			25·63			25·09			0·54
33			50·3			35·73			35·12			0·61
34		24	0·3			45·73			45·14			0·59
35			10·3			55·73			55·17			0·56
36			40·4		4	25·83		58	25·25			0·58
37	13	24	50·4	13	4	35·83	11	58	35·29			0·54

1875, MARCH 7 (*continued*)

SET 19 (*broken* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	13	26	10·0	13	5	55·43	11	59	57·51	1	5	57·92
2			20·0		6	5·43	12	0	7·54			57·89
3			30·0			15·43			17·47			57·96
4			40·0			25·43			27·60			57·83
5			50·0			35·43			38·53			[56·90*]
6		27	20·0		7	5·43		1	7·41			58·02
7			30·0			15·44			17·43			58·01
8			40·0			25·44			27·36			58·08
9			50·0			35·44			37·29			58·15
10		28	1·0			46·44			48·32			58·12
11			10·0			55·44			57·34			58·10
12			20·0		8	5·44		2	7·37			58·07
13			30·0			15·44			17·35			58·09
14			40·0			25·44			27·37			58·07
15			50·0			35·44			37·45			57·99
16		29	10·0			55·44			57·31			58·13
17			20·0		9	5·44		3	7·53			57·91
18			30·0			15·44			17·06			58·38
19			40·0			25·44			27·10			58·34
20			50·0			35·44			37·13			58·31
21		30	1·0			46·44			48·16			58·28
22			10·0			55·44			57·28			58·16
23			20·0		10	5·44		4	7·61			57·83
24			30·0			15·44			17·23			58·21
25			40·0			25·44			27·16			58·28
26			50·0			35·44			37·29			58·15
27		31	10·0			55·44			57·34			58·10
28			20·0		11	5·44		5	7·37			58·07
29			30·0			15·44			17·30			58·14
30			50·0			35·44			37·35			58·09
31		32	1·0			46·44			48·48			57·96
32			10·0			55·44			57·31			58·13
33			20·0		12	5·44		6	7·24			58·20
34			30·0			15·44			17·31			58·13
35			40·0			25·44			27·29			58·15
36			50·0			35·44			37·32			58·12
37	13	33	1·0	13	12	46·44	12	6	48·25			58·19

SET 20 (*broken* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Berlin sidereal time; signals *sent*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	13	33†	41·0	13	13	26·44	12	7	26·75	1	5	59·69
2			51·0			36·44			36·78			59·66
3		34	1·1			46·54			46·81			59·73
4			11·2			56·64			56·83			59·81
5			22·3		14	7·74		8	7·86			59·88
6			31·2			16·64			16·90			59·74
7			51·2			36·64			36·95			59·69
8		35	1·3			46·74			46·98			59·76
9			11·3			56·74			57·01			59·73
10			22·2		15	7·64		9	8·03			59·61
11			31·4			16·84			17·06			59·78
12			41·4			26·84			27·09			59·75
13			51·3			36·74			37·12			59·62
14		36	1·4			46·84			47·14			59·70
15			11·4			56·84			57·17			59·67
16			22·3		16	7·74		10	8·20			59·54
17			31·4			16·84			17·23			59·61
18			41·5			26·94			27·25			59·69
19			51·6			37·04			37·28			59·76
20		37	1·7			47·14			47·31			59·83
21			11·5			56·94			57·34			59·60
22	13	37	22·6	13	17	8·04	12	11	8·37			59·67

[*] Discordant; rejected.

† The hours and minutes have been supplied.

1875, MARCH 7 (*continued*)

SET 20 (*broken* signals)—*continued*

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Berlin sidereal time; signals *sent*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
23	13	37	32·6	13	17	18·04	12	11	17·39	1	5	[60·65*]
24			41·7			27·14			27·42			59·72
25			51·7			37·15			37·45			59·70
26		38	1·6			47·05			47·47			59·58
27			11·8			57·25			57·50			59·75
28			22·8		18	8·25		12	8·53			59·72
29			32·0			17·45			17·56			59·89
30			41·9			27·35			27·58			59·77
31			51·9			37·35			37·61			59·74
32		39	2·0			47·45			47·64			59·81
33			12·0			57·45			57·66			59·79
34			23·0		19	8·45		13	8·70			59·75
35			32·1			17·55			17·73			59·82
36			42·0			27·45			27·76			59·69
37			52·1			37·55			37·78			59·77
38		40	2·0			47·45			47·81			59·64
39			12·1			57·55			57·84			59·71
40			22·2		20	7·65		14	7·87			59·78
41	13	40	42·2	13	20	27·65	12	14	27·92			59·73

SET 21 (*broken* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	13	42	10·0	13	21	55·45	12	15	57·47	1	5	57·98
2			20·0		22	5·45		16	7·39			58·06
3			30·0			15·45			17·32			58·13
4			40·0			25·45			27·25			58·20
5			50·0			35·45			37·27			58·18
6		43	1·0			46·45			48·40			58·05
7			10·0			55·45			57·33			58·12
8			20·0		23	5·45		17	7·36			58·09
9			30·0			15·45			17·18			58·27
10			40·0			25·45			27·31			58·14
11			50·0			35·45			37·24			58·21
12		44	1·0			46·45			48·22			58·23
13			10·0			55·45			57·24			58·21
14			20·0		24	5·45		18	7·23			58·22
15			30·0			15·45			17·46			57·99
16			40·0			25·45			27·38			58·07
17			50·0			35·45			37·36			58·09
18		45	1·0			46·45			48·29			58·16
19			10·0			55·45			57·17			58·28
20			20·0		25	5·45		19	7·39			58·06
21			30·0			15·45			17·32			58·13
22			40·0			25·45			27·25			58·20
23			50·0			35·45			37·28			58·17
24		46	1·0			46·45			48·31			58·14
25			10·0			55·45			57·33			58·12
26			20·0		26	5·45		20	7·31			58·14
27			30·0			15·45			17·29			58·16
28			40·0			25·45			27·31			58·14
29			50·0			35·45			37·24			58·21
30		47	10·0			55·45			57·40			58·05
31			20·0		27	5·45		21	7·22			58·23
32			30·0			15·45			17·15			58·30
33			40·0			25·45			27·08			58·37
34			50·0			35·45			37·30			58·15
35		48	1·0			46·45			48·23			58·22
36			20·0		28	5·46		22	7·19			58·27
37			30·0			15·46			17·26			58·20
38			40·0			25·46			27·24			58·22
39			50·0			35·46			37·27			58·19
40	13	49	1·0	13	28	46·46	12	22	48·31			58·15

[*] Discordant; rejected.

1875, MARCH 7 (*continued*)

SET 22 (*broken* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Berlin sidereal time; signals *sent*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	13	49*	54·0	13	29	39·46	12	23	39·45	1	5	60·01
2		50	4·0			49·46			49·47			59·99
3			14·0			59·46			59·50			59·96
4			25·1		30	10·56		24	10·53			60·03
5			34·0			19·46			19·56			59·90
6			44·0			29·46			29·58			59·88
7			53·9			39·36			39·61			59·75
8		51	4·1			49·56			49·64			59·92
9			14·1			59·56			59·67			59·89
10			25·2		31	10·66		25	10·70			59·96
11			34·2			19·66			19·72			59·94
12			44·8			30·26			30·25			60·01
13			54·2			39·66			39·78			59·88
14		52	4·3			49·76			49·80			59·96
15			14·3			59·76			59·83			59·93
16			25·3		32	10·76		26	10·86			59·90
17			34·3			19·76			19·88			59·88
18			44·4			29·86			29·91			59·95
19			54·4			39·86			39·94			59·92
20		53	4·5			49·96			49·97			59·99
21			14·5			59·96			59·99			59·97
22			24·5		33	9·96		27	10·02			59·94
23			34·5			19·96			20·05			59·91
24			44·6			30·06			30·09			59·97
25			54·7			40·16			40·11			60·05
26		54	4·6			50·06			50·14			59·92
27			14·6		34	0·06		28	0·17			59·89
28			25·7			11·16			11·20			59·96
29			34·7			20·16			20·22			59·94
30			44·7			30·16			30·25			59·91
31			54·8			40·26			40·28			59·98
32		55	4·8			50·26			50·31			59·95
33			14·9		35	0·36		29	0·33			60·03
34			25·8			11·26			11·36			59·90
35			34·9			20·36			20·39			59·97
36			45·0			30·46			30·42			60·04
37			55·0			40·46			40·44			60·02
38		56	5·0			50·46			50·47			59·99
39			15·0		36	0·46		30	0·50			59·96
40			26·1			11·56			11·53			60·03
41			35·1			20·56			20·55			60·01
42			45·0			30·46			30·58			59·88
43	13	56	55·1	13	36	40·56	12	30	40·61			59·95

SET 23 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	13	58	20·0	13	38	5·46	12	32	7·24	1	5	58·22
2			30·0			15·46			17·28			58·18
3			40·0			25·46			27·31			58·15
4			50·0			35·47			37·29			58·18
5		59	1·0			46·47			48·26			58·21
6			20·0		39	5·47		33	7·22			58·25
7			30·0			15·47			17·29			58·18
8			40·0			25·47			27·47			58·00
9	14	0	1·0			46·47			48·13			58·34
10			10·0			55·47			57·35			58·12
11			30·0		40	15·47		34	17·31			58·16
12			40·0			25·47			27·34			58·13
13			50·0			35·47			37·36			58·11
14		1	1·0			46·47			48·29			58·18
15			10·0			55·47			57·32			58·15
16	14	1	20·0	13	41	5·47	12	35	7·35			58·12

* The hours and minutes have been supplied.

1875, MARCH 7 (*continued*)

SET 23 (*made* signals)—*continued*

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
17	14	1	30·0	13	41	15·47	12	35	17·37	1	5	58·10
18			40·0			25·47			27·35			58·12
19			50·0			35·47			37·33			58·14
20		2	1·0			46·47			48·35			58·12
21			10·0			55·47			57·33			58·14
22			20·0		42	5·47		36	7·26			58·21
23			30·0			15·47			17·34			58·13
24			40·0			25·47			27·31			58·16
25			50·0			35·47			37·29			58·18
26		3	1·0			46·47			48·27			58·20
27			20·0		43	5·47		37	7·28			58·19
28			30·0			15·47			17·41			58·06
29			40·0			25·47			27·29			58·18
30			50·0			35·47			37·26			58·21
31		4	0·0			45·47			47·29			58·18
32			10·0			55·47			57·32			58·15
33			20·0		44	5·47		38	7·35			58·12
34			30·0			15·47			17·37			58·10
35			40·0			25·47			27·35			58·12
36			50·0			35·47			37·33			58·14
37	14	5	1·0	13	44	46·47	12	38	48·36			58·11

SET 24 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Berlin sidereal time; signals *sent*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	14	5	27·5	13	45	12·97	12	39	13·03	1	5	59·94
2			36·6			22·07			22·05			60·02
3			46·8			32·27			32·08			60·19
4		6	9·8			55·27			52·14			[63·13*]
5			16·8		46	2·27		40	2·16			60·11
6			27·8			13·27			13·19			60·08
7			36·9			22·37			22·21			60·16
8			46·9			32·37			32·24			60·13
9			57·0			42·47			42·27			60·20
10		7	6·9			52·37			52·30			60·07
11			16·9		47	2·37		41	2·32			60·05
12			27·9			13·37			13·35			60·02
13			37·0			22·47			22·38			60·09
14			47·0			32·47			32·41			60·06
15			57·1			42·57			42·43			60·14
16		8	7·1			52·57			52·46			60·11
17			27·1		48	12·57		42	12·53			60·04
18			37·2			22·67			22·55			60·12
19			47·2			32·67			32·58			60·09
20		9	7·2			52·68			52·64			60·04
21			17·2		49	2·68		43	2·66			60·02
22			28·3			13·78			13·69			60·09
23			37·3			22·78			22·72			60·06
24			47·4			32·88			32·74			60·14
25		10	17·4		50	2·88		44	2·83			60·05
26			28·5			13·98			13·86			60·12
27			37·5			22·98			22·88			60·10
28			47·5			32·98			32·91			60·07
29			57·5			42·98			42·94			60·04
30		11	7·6			53·08			52·96			60·12
31			17·6		51	3·08		45	2·99			60·09
32			28·6			14·08			14·02			60·06
33			37·7			23·18			23·05			60·13
34			47·8			33·28			33·07			60·21
35			57·7			43·18			43·10			60·08
36		12	7·7			53·18			53·13			60·05
37			17·8		52	3·28		46	3·16			60·12
38	14	12	28·8	13	52	14·28	12	46	14·19			60·09

[*] Discordant; rejected.

1875. MARCH 10

SET 25 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time ; signals *sent*			Corresponding Berlin sidereal time ; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	16	39	20·0	16	19	11·20	15	13	13·14	1	5	58·06
2			30·0			21·20			23·37			57·83
3			40·0			31·20			33·19			58·01
4			50·0			41·20			43·12			58·08
5		40	1·0			52·20			54·15			58·05
6			10·0		20	1·20		14	3·29			57·91
7			20·0			11·20			13·36			57·84
8			30·0			21·20			23·24			57·96
9			40·0			31·20			33·27			57·93
10			50·0			41·21			43·29			57·92
11		41	1·0			52·21			54·37			57·84
12			10·0		21	1·21		15	3·35			57·86
13			20·0			11·21			13·28			57·93
14			30·0			21·21			23·25			57·96
15			40·0			31·21			33·33			57·88
16			50·0			41·21			43·26			57·95
17		42	1·0			52·21			54·29			57·92
18			10·0		22	1·21		16	3·31			57·90
19			20·0			11·21			13·24			57·97
20	16	42	30·0	16	22	21·21	15	16	23·22			57·99

SET 26 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time ; signals *received*			Corresponding Berlin sidereal time ; signals *sent*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	16	48	10·3	16	28	1·51	15	22	1·50	1	5	60·01
2			20·3			11·51			11·53			59·98
3			30·4			21·61			21·56			60·05
4			50·4			41·62			41·61			60·01
5		49	0·4			51·62			51·64			59·98
6			10·5		29	1·72		23	1·67			60·05
7			20·6			11·82			11·69			60·13
8			30·7			21·92			21·72			60·20
9			41·7			32·92			32·75			60·17
10		50	0·8			52·02			51·80			60·22
11			10·7		30	1·92		24	1·83			60·09
12			20·7			11·92			11·86			60·06
13			30·8			22·02			21·89			60·13
14			41·8			33·02			32·92			60·10
15			50·7			41·92			41·95			59·97
16		51	0·8			52·02			51·98			60·04
17			10·8		31	2·02		25	2·00			60·02
18			20·9			12·12			12·03			60·09
19			30·9			22·12			22·06			60·06
20			41·9			33·12			33·09			60·03
21			51·0			42·22			42·11			60·11
22		52	0·9			52·12			52·14			59·98
23			11·0		32	2·22		26	2·17			60·05
24			21·0			12·22			12·20			60·02
25			31·0			22·22			22·22			60·00
26			42·0			33·22			33·25			59·97
27			51·1			42·32			42·28			60·04
28		53	1·0			52·22			52·31			59·91
29	16	53	11·1	16	33	2·32	15	27	2·33			59·99

1875, MARCH 12

SET 27 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	16	55	10·0	16	35	5·00	15	29	6·80	1	5	58·20
2			20·0			15·00			16·93			58·07
3			30·0			25·00			26·85			58·15
4			40·0			35·01			36·88			58·13
5			50·0			45·01			46·91			58·10
6		56	1·0			56·01			57·94			58·07
7			10·0		36	5·01		30	6·96			58·05
8			20·0			15·01			16·79			58·22
9			30·0			25·01			26·92			58·09
10			40·0			35·01			36·90			58·11
11			50·0			45·01			46·82			58·19
12		57	0·0			55·01			56·90			58·11
13			10·0		37	5·01		31	6·88			58·13
14			20·0			15·01			16·86			58·15
15			30·0			25·01			26·88			58·13
16			40·0			35·01			36·82			58·19
17			50·0			45·01			46·80			58·21
18		58	1·0			56·01			57·83			58·18
19			10·0		38	5·01		32	6·80			58·21
20			20·0			15·01			16·83			58·18
21			30·0			25·01			26·91			58·10
22			40·0			35·01			36·88			58·13
23			50·0			45·01			46·91			58·10
24		59	1·0			56·01			57·84			58·17
25			10·0		39	5·01		33	6·87			58·14
26			20·0			15·01			16·89			58·12
27			30·0			25·01			26·77			58·24
28			40·0			35·01			36·85			58·16
29			50·0			45·01			46·92			58·09
30	17	0	0·0			55·01			56·85			58·16
31			10·0		40	5·01		34	6·88			58·13
32			30·0			25·01			26·88			58·13
33			40·0			35·01			36·86			58·15
34			50·0			45·01			46·84			58·17
35		1	1·0			56·01			57·92			58·09
36			10·0		41	5·01		35	6·84			58·17
37			20·0			15·02			16·82			58·20
38			30·0			25·02			26·90			58·12
39			40·0			35·02			36·88			58·14
40			50·0			45·02			46·91			58·11
41	17	2	0·0	16	41	55·02	16	35	57·84			[57·18*]

SET 28 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Berlin sidereal time; signals *sent*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	17	2	59·3	16	42	54·32	15	36	54·10	1	6	0·22
2		3	9·2		43	4·22		37	4·12			0·10
3			19·4			14·42			14·15			0·27
4			29·4			24·42			24·18			0·24
5			40·4			35·42			35·21			0·21
6			49·5			44·52			44·23			0·29
7			59·5			54·52			54·26			0·26
8		4	9·5		44	4·52		38	4·29			0·23
9			19·6			14·62			14·32			0·30
10			29·5			24·52			24·34			0·18
11			40·6			35·62			35·37			0·25
12			49·6			44·62			44·40			0·22
13			59·6			54·62			54·42			0·20
14		5	9·7		45	4·72		39	4·45			0·27
15	17	5	19·7	16	45	14·72	15	39	14·48			0·24

[*] Discordant; rejected.

1875, MARCH 12 (*continued*)

SET 28 (*made* signals)—*continued*

Number of signal	Time by chronometer 43	Alexandria sidereal time; signals *received*	Corresponding Berlin sidereal time; signals *sent*	Resulting longitude, Alexandria east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
16	17 5 29·7	16 45 24·72	15 39 24·51	1 6 0·21
17	41·7	36·72	35·54	[1·18*]
18	49·8	44·82	44·56	0·26
19	59·8	54·82	54·59	0·23
20	6 9·9	46 4·92	40 4·62	0·30
21	19·8	14·82	14·64	0·18
22	29·8	24·82	24·67	0·15
23	40·9	35·92	35·70	0·22
24	49·9	44·93	44·74	0·19
25	7 0·0	55·03	54·76	0·27
26	10·0	47 5·03	41 4·79	0·24
27	20·0	15·03	14·82	0·21
28	30·0	25·03	24·85	0·18
29	41·1	36·13	35·88	0·25
30	50·1	45·13	44·90	0·23
31	8 0·3	55·33	54·93	0·40
32	20·2	48 15·23	42 14·98	0·25
33	30·9	25·93	25·01	[0·92*]
34	17 8 41·2	16 48 36·23	15 42 36·04	0·19

SET 29 (*made* signals)

Number of signal	Time by chronometer 43	Alexandria sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Alexandria east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	17 12 1·0	16 51 56·03	15 45 57·90	1 5 58·13
2	20·0	52 15·03	46 17·05	57·98
3	30·0	25·04	26·98	58·06
4	40·0	35·04	36·96	58·08
5	50·0	45·04	46·88	58·16
6	13 1·0	56·04	57·86	58·18
7	20·0	53 15·04	47 16·92	58·12
8	30·0	25·04	27·04	58·00
9	40·0	35·04	36·97	58·07
10	50·0	45·04	46·95	58·09
11	14 1·0	56·04	57·93	58·11
12	10·0	54 5·04	48 6·90	58·14
13	20·0	15·04	16·93	58·11
14	30·0	25·04	26·91	58·13
15	40·0	35·04	36·88	58·16
16	50·0	45·04	46·96	58·08
17	15 1·0	56·04	57·89	58·15
18	10·0	55 5·04	49 6·92	58·12
19	20·0	15·04	16·89	58·15
20	30·0	25·04	26·87	58·17
21	40·0	35·04	36·95	58·09
22	50·0	45·04	46·93	58·11
23	16 1·0	56·04	57·96	58·08
24	10·0	56 5·04	50 6·93	58·11
25	20·0	15·04	16·91	58·13
26	30·0	25·04	26·88	58·16
27	40·0	35·04	36·97	58·07
28	17 1·0	56·04	57·91	58·13
29	20·0	57 15·04	51 16·98	58·06
30	30·0	25·04	27·01	58·03
31	40·0	35·04	36·94	58·10
32	50·0	45·04	46·96	58·08
33	18 1·0	56·04	57·94	58·10
34	10·0	58 5·04	52 7·02	58·02
35	20·0	15·05	16·90	58·15
36	40·0	35·05	36·90	58·15
37	17 18 50·0	16 58 45·05	15 52 46·93	58·12

[*] Discordant; rejected.

1875, MARCH 12 (*continued*)

SET 30 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Berlin sidereal time; signals *sent*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	17	20	2·1	16	59	57·15	15	53	56·92	1	6	0·23
2			12·1	17	0	7·15		54	6·95			0·20
3			22·2			17·25			16·97			0·28
4			32·0			27·05			27·00			0·05
5			43·2			38·25			38·03			0·22
6			52·1			47·15			47·06			0·09
7		21	2·3			57·35			57·08			0·27
8			12·3		1	7·35		55	7·11			0·24
9			22·3			17·35			17·15			0·20
10			32·3			27·35			27·18			0·17
11			43·4			38·45			38·21			0·24
12			52·4			47·45			47·23			0·22
13		22	2·4			57·45			57·26			0·19
14			12·4		2	7·45		56	7·28			0·17
15			22·5			17·55			17·31			0·24
16			32·5			27·55			27·34			0·21
17	17	22	43·5	17	2	38·55	15	56	38·37			0·18

SET 31 (*broken* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Berlin sidereal time; signals *sent*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	18	14	40·8	17	54	35·94	16	48	35·98	1	5	59·96
2			51·8			46·94			47·01			59·93
3		15	1·8			56·94			56·04			[60·90*]
4			10·8		55	5·94		49	6·07			59·87
5			20·8			15·94			16·10			59·84
6			30·9			26·04			26·13			59·91
7			40·9			36·04			36·16			59·88
8			51·8			46·94			47·19			59·75
9		16	2·8			57·94			56·21			59·73
10			10·9		56	6·04		50	6·24			59·80
11			22·8			17·94			16·27			[61·67*]
12			31·1			26·24			26·29			59·95
13			41·1			36·24			36·32			59·92
14			52·1			47·24			47·35			59·89
15		17	1·2			56·34			56·38			59·96
16			11·2		57	6·34		51	6·40			59·94
17			21·3			16·44			16·43			60·01
18			31·1			26·24			26·46			59·78
19			42·3			37·44			36·48			[60·96*]
20			52·4			47·54			47·51			60·03
21		18	1·4			56·54			56·54			60·00
22			11·4		58	6·54		52	6·57			59·97
23			21·4			16·54			16·59			59·95
24			31·8			26·94			26·62			60·32
25			52·4			47·54			47·68			59·86
26		19	11·5		59	6·64		53	6·73			59·91
27			21·6			16·74			16·76			59·98
28			31·7			26·84			26·79			60·05
29			41·7			36·84			36·81			60·03
30			52 6			47·74			47·84			59·90
31		20	11·7	18	0	6·84		54	6·90			59·94
32			21·7			16·84			16·93			59·91
33			31·8			26·94			26·96			59·98
34			41·8			36·94			36·99			59·95
35			52·8			47·94			48·02			59·92
36	18	21	1·9	18	0	57·04	16	54	57·04			60·00

[*] Discordant; rejected.

1875, MARCH 12 (*continued*)

SET 32 (*broken* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time ; signals *sent*			Corresponding Berlin sidereal time ; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	18	23	1·0	18	2	56·15	16	56	58·88	1	5	57·27
2			10·0		3	5·15		57	8·70			[56·45*]
3			20·0			15·15			17·93			57·22
4			30·0			25·15			27·75			57·40
5			40·0			35 15			37·58			57·57
6			50·0			45·15			47·51			57·64
7		24	1·0			56·15			58·54			57·61
8			10·0		4	5·15		58	8·06			57·09
9			30·0			25·15			27·62			57·53
10			40·0			35·15			37·64			57·51
11			50·0			45·15			47·47			57·68
12		25	1·0			56·15			58·66			57·49
13			10·0		5	5·15		59	7·34			57·81
14			20·0			15·15			17·76			57·39
15		26	10·0		6	5·15	17	0	7·30			57·85
16			20·0			15·15			18·33			[56·82*]
17			30·0			25·15			27·75			57·40
18			40·0			35·15			37·78			57·37
19			50·0			45·15			47·51			57·64
20	18	27	1·0	18	6	56·15	17	0	58·74			57·41

1875, MARCH 13

SET 33 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time ; signals *sent*			Corresponding Berlin sidereal time ; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	15	21	20·0	15	1	16·79	13	55	18·83	1	5	57·96
2			30·0			26·79			28·90			57·89
3			40·0			36·79			38·98			57·81
4			50·0			46·79			48·96			57·83
5		22	0·0			56·79			59·09			57·70
6			10·0		2	6·79		56	9·11			57·68
7			20·0			16·79			19·04			57·75
8			30·0			26·79			28·97			57·82
9			40·0			36·79			38·95			57·84
10			50·0			46·79			49·02			57·77
11		23	1·0			57·79		57	0·00			57·79
12			10·0		3	6·79			8·98			57·81
13			20·0			16·79			19·01			57·78
14			30·0			26·79			28·98			57·81
15			40·0			36·79			39·01			57·78
16			50·0			46·79			48·99			57·80
17		24	0·0			56·79			59·02			57·77
18			10·0		4	6·79		58	8·95			57·84
19			20·0			16·79			18·98			57·81
20			30·0			26·79			29·11			57·68
21			40·0			36·79			38·93			57·86
22			50·0			46·79			48·96			57·83
23		25	1·0			57·79			59·99			57·80
24			10·0		5	6·79		59	9·02			57·77
25			20·0			16·79			19·04			57·75
26			30·0			26·79			29·07			57·72
27			40·0			36·79			39·00			57·79
28			50·0			46·79			49·03			57·76
29		26	1·0			57·80	14	0	0·01			57·79
30			10·0		6	6·80			8·98			57·82
31			20·0			16·80			18·96			57·84
32			30·0			26·80			28·98			57·82
33	15	26	50·0	15	6	46·80	14	0	48·99			57·81

[*] Discordant ; rejected.

1875, MARCH 13 (*continued*)

SET 34 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Berlin sidereal time; signals *sent*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	15	28	23·2	15	8	20·00	14	2	20·04	1	5	59·96
2			32·3			29·10			29·06			60·04
3			42·3			39·10			39·09			60·01
4			52·3			49·10			49·13			59·97
5		29	12·4		9	9·20		3	9·18			60·02
6			23·4			20·20			20·21			59·99
7			32·4			29·20			29·24			59·96
8			42·4			39·20			39·27			59·93
9			52·5			49·30			49·29			60·01
10		30	2·6			59·40			59·32			60·08
11			12·6		10	9·40		4	9·35			60·05
12			22·6			19·40			19·38			60·02
13			32·6			29·40			29·40			60·00
14			42·7			39·50			39·43			60·07
15			52·6			49·40			49·46			59·94
16		31	2·7			59·50			59·48			60·02
17			12·7		11	9·50		5	9·51			59·99
18			23·8			20·60			20·54			60·06
19			32·8			29·61			29·57			60·04
20			42·7			39·51			39·59			59·92
21			52·8			49·61			49·62			59·99
22		32	2·8			59·61			59·65			59·96
23			12·8		12	9·61		6	9·68			59·93
24			23·9			20·71			20·71			60·00
25			32·9			29·71			29·73			59·98
26			42·9			39·71			39·76			59·95
27			52·9			49·71			49·79			59·92
28		33	2·9			59·71			59·81			59·90
29			12·9		13	9·71		7	9·84			59·87
30			24·0			20·81			20·87			59·94
31			33·0			29·81			29·91			59·90
32			43·0			39·81			39·93			59·88
33			53·1			49·91			49·96			59·95
34		34	3·2		14	0·01			59·99			60·02
35			13·1			9·91		8	10·02			59·89
36			24·2			21·01			21·04			59·97
37			33·3			30·11			30·07			60·04
38			43·2			40·01			40·10			59·91
39	15	34	53·3	15	14	50·11	14	8	50·12			59·99

SET 35 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	15	36	20·0	15	16	16·81	14	10	18·76	1	5	58·05
2			30·0			26·81			29·09			57·72
3			40·0			36·81			38·97			57·84
4			50·0			46·82			49·05			57·77
5		37	1·0			57·82		11	0·03			57·79
6			10·0		17	6·82			9·05			57·77
7			20·0			16·82			19·03			57·79
8			30·0			26·82			29·06			57·76
9			40·0			36·82			39·08			57·74
10			50·0			46·82			49·11			57·71
11		38	1·0			57·82		12	0·04			57·78
12			10·0		18	6·82			9·07			57·75
13			20·0			16·82			19·00			57·82
14			30·0			26·82			29·03			57·79
15			40·0			36·82			39·06			57·76
16			50·0			46·82			49·04			57·78
17		39	1·0			57·82		13	0·01			57·81
18			10·0		19	6·82			9·09			57·73
19			20·0			16·82			19·17			57·65
20	15	39	30·0	15	19	26·82	14	13	28·99			57·83

1875, MARCH 13 (*continued*)

SET 35 (*made* signals)—*continued*

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
21	15	39	40·0	15	19	36·82	14	13	39·07	1	5	57·75
22			50·0			46·82			49·05			57·77
23		40	1·0			57·82		14	0·03			57·79
24			10·0		20	6·82			9·10			57·72
25			20·0			16·82			19·03			57·79
26			30·0			26·82			29·06			57·76
27			40·0			36·82			39·09			57·73
28			50·0			46·82			49·11			57·71
29		41	1·0			57·82		15	0·09			57·73
30			10·0		21	6·82			9·07			57·75
31			20·0			16·82			19·09			57·73
32			30·0			26·82			29·07			57·75
33			40·0			36·82			39·05			57·77
34			50·0			46·82			49·08			57·74
35		42	1·0			57·82		16	0·06			57·76
36			10·0		22	6·82			9·08			57·74
37			20·0			16·83			19·06			57·77
38			30·0			26·83			29·09			57·74
39			40·0			36·83			39·11			57·72
40	15	43	1·0	15	22	57·83	14	17	0·03			57·80

SET 36 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Berlin sidereal time; signals *sent*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	15	43	44·8	15	23	41·63	14	17	41·59	1	5	60·04
2			54·8			51·63			51·62			60·01
3		44	4·7		24	1·53		18	1·65			59·88
4			14·8			11·63			11·68			59·95
5			25·8			22·63			22·71			59·92
6			34·8			31·63			31·73			59·90
7			44·9			41·73			41·76			59·97
8			54·9			51·73			51·79			59·94
9		45	4·9		25	1·73		19	1·81			59·92
10			14·9			11·73			11·84			59·89
11			26·0			22·83			22·87			59·96
12			35·0			31·83			31·89			59·94
13			45·0			41·83			41·92			59·91
14			55·1			51·93			51·95			59·98
15		46	5·0		26	1·83		20	1·98			59·85
16			15·1			11·93			12·00			59·93
17			26·1			22·93			23·03			59·90
18			35·1			31·93			32·06			59·87
19			45·2			42·03			42·09			59·94
20			55·2			52·03			52·11			59·92
21		47	5·2		27	2·03		21	2·14			59·89
22			15·3			12·13			12·17			59·96
23			26·4			23·23			23·20			60·03
24			35·4			32·23			32·22			60·01
25			45·4			42·24			42·26			59·98
26		48	5·4		28	2·24		22	2·32			59·92
27			15·6			12·44			12·34			60·10
28			45·5			42·34			42·43			59·91
29			55·6			52·44			52·45			59·99
30		49	5·6		29	2·44		23	2·48			59·96
31			15·5			12·34			12·51			59·83
32			26·7			23·54			23·54			60·00
33			35·7			32·54			32·56			59·98
34			45·7			42·54			42·59			59·95
35			55·7			52·54			52·62			59·92
36		50	5·8		30	2·64		24	2·64			60·00
37			16·7			12·54			12·67			59·87
38			26·8			23·64			23·70			59·94
39			35·8			32·64			32·73			59·91
40	15	50	45·8	15	30	42·64	14	24	42·75			59·89

1875, MARCH 14

SET 37 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	15	36	28·0	15	16	19·07	14	10	21·59	1	5	57·48
2			30·0			29·07			31·41			57·66
3			50·0			49·07			51·47			57·60
4		52	10·0		32	9·10		26	11·46			57·64
5			20·0			19·10			21·49			57·61
6			30·0			29·10			31·46			57·64
7			40·0			39·10			41·44			57·66
8		53	10·0		33	9·10		27	11·27			57·83
9			20·0			19·10			21·50			57·60
10			30·0			29·10			31·43			57·67
11			40·0			39·10			41·41			57·69
12	15	54	1·0	15	34	0·10	14	28	2·31			57·79

SET 38 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Berlin sidereal time; signals *sent*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	15	55	43·4	15	35	42·51	14	29	42·80	1	5	59·71
2			53·4			52·51			52·82			59·69
3		56	3·5		36	2·61		30	2·85			59·76
4			13·5			12·61			12·88			59·73
5			23·6			22·71			22·91			59·80
6			33·6			32·71			32·93			59·78
7			43·6			42·71			42·96			59·75
8			53·7			52·81			52·99			59·82
9		57	3·8		37	2·91		31	3·02			59·89
10			13·7			12·81			13·04			59·77
11			24·8			23·91			24·07			59·84
12			34·8			33·91			34·10			59·81
13			45·9			45·01			45·13			59·88
14			54·9			54·01			53·15			[60·86*]
15		58	4·0		38	3·11		32	3·18			59·93
16			14·0			13·11			13·21			59·90
17			23·9			23·01			23·24			59·77
18			34·0			33·11			33·26			59·85
19			44·1			43·21			43·29			59·92
20			54·1			53·21			53·32			59·89
21		59	4·1		39	3·21		33	3·35			59·86
22			14·2			13·31			13·37			59·94
23			25·1			24·21			24·40			59·81
24			34·1			33·21			33·43			59·78
25			44·2			43·31			43·45			59·86
26			54·2			53·31			53·48			59·83
27	16	0	4·3		40	3·41		34	3·52			59·89
28			14·3			13·41			13·55			59·86
29			25·3			24·41			24·58			59·83
30			34·4			33·51			33·60			59·91
31			44·4			43·51			43·63			59·88
32			54·5			53·62			53·66			59·96
33		1	4·4		41	3·52		35	3·68			59·84
34			14·5			13·62			13·71			59·91
35			25·6			24·72			24·74			59·98
36			34·6			33·72			33·77			59·95
37			44·5			43·62			43·79			59·83
38			54·6			53·72			53·82			59·90
39		2	4·7		42	3·82		36	3·85			59·97
40			14·6			13·72			13·88			59·84
41			25·6			24·72			24·91			59·81
42	16	2	34·7	15	42	33·82	14	36	33·93			59·89

[*] Discordant; rejected.

1875, MARCH 14 (*continued*)

SET 39 (*made* signals)

Number of signal	Time by chronometer 43	Alexandria sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Alexandria east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	16 5 1·0	15 45 0·12	14 39 2·13	[1 5 57·99*]
2	20·0	19·12	21·50	1 5 57·62
3	30·0	29·12	31·48	57·64
4	40·0	39·12	41·45	57·67
5	50·0	49·12	51·53	57·59
6	6 1·0	46 0·12	40 2·51	57·61
7	10·0	9·12	11·48	57·64
8	20·0	19·12	21·61	57·51
9	30·0	29·12	31·44	57·68
10	40·0	39·13	41·52	57·61
11	50·0	49·13	51·44	57·69
12	7 1·0	47 0·13	41 2·47	57·66
13	20·0	19·13	21·42	57·71
14	30·0	29·13	31·50	57·63
15	40·0	39·13	41·48	57·65
16	50·0	49·13	51·46	57·67
17	8 1·0	48 0·13	42 2·44	57·69
18	10·0	9·13	11·41	57·72
19	20·0	19·13	21·44	57·69
20	30·0	29·13	31·42	57·71
21	40·0	39·13	41·44	57·69
22	50·0	49·13	51·47	57·66
23	9 1·0	49 0·13	43 2·50	57·63
24	10·0	9·13	11·53	57·60
25	20·0	19·13	21·50	57·63
26	30·0	29·13	31·43	57·70
27	40·0	39·13	41·41	57·72
28	50·0	49·13	51·43	57·70
29	10 1·0	50 0·13	44 2·46	57·67
30	10·0	9·13	11·64	57·49
31	20·0	19·13	21·32	57·81
32	30·0	29·13	31·44	57·69
33	40·0	39·13	41·48	57·65
34	50·0	49·13	51·46	57·67
35	16 11 1·0	15 51 0·13	14 45 2·44	57·69

SET 40 (*made* signals)

Number of signal	Time by chronometer 43	Alexandria sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Alexandria east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	16 26 20·0	16 6 19·16	15 0 21·47	1 5 57·69
2	30·0	29·16	31·44	57·72
3	40·0	39·16	41·47	57·69
4	50·0	49·16	51·45	57·71
5	27 1·0	7 0·16	1 2·48	57·68
6	10·0	9·16	11·46	57·70
7	20·0	19·16	21·44	57·72
8	30·0	29·16	31·42	57·74
9	40·0	39·16	41·50	57·66
10	50·0	49·16	51·47	57·69
11	28 1·0	8 0·16	2 2·50	57·66
12	50·0	49·16	51·44	57·72
13	29 1·0	9 0·17	3 2·42	57·75
14	10·0	9·17	11·49	57·68
15	20·0	19·17	21·52	57·65
16	30·0	29·17	31·50	57·67
17	40·0	39·17	41·52	57·65
18	50·0	49·17	51·50	57·67
19	16 30 0·0	16 9 59·17	15 4 1·58	57·59

[*] Rejected because the current may not have been fully on.

1875, MARCH 14 (*continued*)

SET 40 (*made* signals)—*continued*

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
20	16	30	10·0	16	10	9·17	15	4	11·51	1	5	57·66
21			20·0			19·17			21·53			57·64
22			30·0			29·17			31·56			57·61
23			40·0			39·17			41·49			57·68
24			50·0			49·17			51·57			57·60
25		31	1·0		11	0·17		5	2·55			57·62
26			10·0			9·17			11·52			57·65
27			20·0			19·17			21·50			57·67
28			30·0			29·17			31·47			57·70
29			40·0			39·17			41·50			57·67
30			50·0			49·17			51·48			57·69
31		32	0·0			59·17		6	1·51			57·66
32			10·0		12	9·17			11·48			57·69
33			20·0			19·17			21·46			57·71
34			30·0			29·17			31·50			57·67
35			50·0			49·17			51·50			57·67
36	16	33	1·0	16	13	0·17	15	7	2·53			57·64

SET 41 (*made* signals)

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Berlin sidereal time; signals *sent*			Resulting longitude, Alexandria east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	16	33*	49·8	16	13	48·97	15	7	49·11	1	5	59·86
2			59·8			58·97			59·14			59·83
3		34	9·9		14	9·07		8	9·16			59·91
4			19·9			19·07			19·19			59·88
5			30·9			30·08			30·22			59·86
6			40·0			39·18			39·25			59·93
7			50·0			49·18			49·27			59·91
8		35	0·1			59·28			59·30			59·98
9			11·1		15	10·28		9	10·33			59·95
10			20·1			19·28			19·36			59·92
11			30·1			29·28			30·39			[58·89†]
12			40·1			39·28			39·41			59·87
13			50·0			49·18			49·44			59·74
14		36	0·1			59·28			59·47			59·81
15			10·2		16	9·38		10	9·49			59·89
16			20·1			19·28			19·52			59·76
17			30·2			29·38			29·55			59·83
18			40·3			39·48			39·58			59·90
19			50·4			49·58			49·60			59·98
20		37	0·3			59·48			59·63			59·85
21			10·4		17	9·58		11	9·66			59·92
22			20·4			19·58			19·69			59·89
23			31·4			30·58			30·72			59·86
24			40·5			39·68			39·74			59·94
25			50·5			49·68			49·77			59·91
26		38	0·6			59·78			59·80			59·98
27			20·6		18	19·78		12	19·86			59·92
28			31·6			30·78			30·89			59·89
29			50·7			49·88			49·94			59·94
30		39	10·7		19	9·88		13	10·00			59·88
31			20·7			19·88			20·02			59·86
32			40·8			39·98			40·08			59·90
33			50·8			49·98			50·11			59·87
34		40	1·8		20	0·99		14	0·13			[60·86†]
35			10·8			9·99			10·16			59·83
36			20·8			19·99			20·19			59·80
37			31·8			30·99			31·22			59·77
38	16	40	40·9	16	20	40·09	16	14	40·24			59·85

* All the Alexandria times in this set have been decreased 1m.

[†] Discordant; rejected.

Taking the means of the results of the foregoing sets, we obtain :—

Difference of longitude by signals sent from Alexandria and recorded at Berlin.

Date	Set	No. of signals	Resulting longitude, Alexandria east of Berlin	By *made* signals	By *broken* signals
			h. m. s.	h. m. s.	h. m. s.
1875, Feb. 28	1	20	1 5 58·311* *made* signals	...	...
„ „	3	21	57·990 *broken* „	...	...
„ „	5	21	58·036 *broken* „	...	...
„ „	8	50	58·378 *made* „	1 5 58·344	1 5 58·013
„ March 6	9	30	1 5 58·122* *made* „	...	...
„ „	11	35	58·102* *made* „	...	...
„ „	13	35	58·143 *broken* „	...	...
„ „	15	39	58·154 *broken* „	1 5 58·112	1 5 58·148
„ March 7	17	37	1 5 58·294 *made* „	...	...
„ „	19	36	58·099 *broken* „	...	...
„ „	21	40	58·162 *broken* „	...	...
„ „	23	37	58·155 *made* „	1 5 58·225	1 5 58·131
„ March 10	25	20	1 5 57·940 *made* „	1 5 57·940	...
„ March 12	27	40	1 5 58·142 *made* „	...	...
„ „	29	37	58·105* *made* „	...	...
„ „	32	18	57·493 *broken* „	1 5 58·124	15 57·493
„ March 13	33	33	1 5 57·796 *made* „	...	...
„ „	35	40	57·766* *made* „	1 5 57·781	...
„ March 14	37	12	1 5 57·656 *made* „	...	...
„ „	39	34	57·659* *made* „	...	...
„ „	40	36	57·674* *made* „	1 5 57·663	...

Difference of longitude by signals sent from Berlin and recorded at Alexandria.

Date	Set	No. of signals	Resulting longitude, Alexandria east of Berlin	By *made* signals	By *broken* signals
			h. m. s.	h. m. s.	h. m. s.
1875, Feb. 28	2	23	1 5 60·513* *made* signals	...	...
„ „	4	17	59·734 *broken* „	...	...
„ „	6	23	59·687 *broken* „	...	...
„ „	7	21	60·461 *made* „	1 5 60·487	1 5 59·710
„ March 6	10	36	1 5 60·128* *made* „	...	...
„ „	12	33	60·098* *made* „	...	...
„ „	14	35	59·617 *broken* „	...	...
„ „	16	37	59·648 *broken* „	1 5 60·113	1 5 59·632
„ March 7	18	37	1 5 60·559 *made* „	...	...
„ „	20	40	59·722 *broken* „	...	...
„ „	22	43	59·949 *broken* „	...	...
„ „	24	37	60·089 *made* „	1 5 60·324	1 5 59·836
„ March 10	26	29	1 5 60·050* *made* „	1 5 60·050	...
„ March 12	28	32	1 5 60·232 *made* „	...	...
„ „	30	17	60·200 *made* „	...	...
„ „	31	33	59·934* *broken* „	1 5 60·216	1 5 59·934
„ March 13	34	39	1 5 59·976 *made* „	...	...
„ „	36	40	59·942* *made* „	1 5 59·959	...
„ March 14	38	41	1 5 59·849* *made* „	...	...
„ „	41	36	59·880* *made* „	1 5 59·864	...

* The character (*made* or *broken*) of the signals marked with an asterisk has been assumed.

Combining these results on the supposition that the current time is the same in both directions, we have :—

		By *made* signals h. m. s.	By *broken* signals h. m. s.	Current time by *made* signals s.	Current time by *broken* signals s.
1875, Feb. 28	Alexandria east of Berlin	1 5 59·416	1 5 58·862	1·072	0·848
„ March 6	„ „	59·112	58·890	1·000	0·742
„ „ 7	„ „	59·274	58·983	1·050	0·853
„ „ 10	„ „	58·995	...	1·055	...
„ „ 12	„ „	59·170	58·715	1·046	1·222
„ „ 13	„ „	58·870	...	1·089	...
„ „ 14	„ „	58·764	...	1·100	...

From these results, we get for *made broken* signals $+0^{s}\cdot380$, or $-0^{s}\cdot190$ to be applied to *made* signals in order to reduce to the mean of *made* and *broken*. Then, as the time determinations at Alexandria on March 6 and 7 are somewhat unsatisfactory, and the sets on some days are more complete than on others, we have assigned special weights to each day. We thus obtain :—

		h. m. s.	Weight
1875, Feb. 28	Alexandria east of Berlin	1 5 59·139	6
„ March 6	„ „	59·001	2
„ „ 7	„ „	59·128	2
„ „ 10	„ „	58·805	1
„ „ 12	„ „	58·942	4
„ „ 13	„ „	58·680	2
„ „ 14	„ „	58·574	3

Or—

	h. m. s.
Alexandria east of Berlin	1 5 58·94
Personal equation between Dr. Becker and Mr. Gill in observing transits* . .	−0·21
„ „ „ Prof. Auwers and Mr. Gill in sending signals† . .	+0·08

Therefore we finally get by direct signals :—

	h. m. s.
Alexandria east of Berlin	1 5 58·81

As will be seen from the foregoing and the next chapter, the longitude of Alexandria was determined both by signals direct from Berlin, and by the lengths Alexandria-Malta and Malta-Berlin. The signals in the direct determination are not altogether satisfactory, there being a rather large difference between the results given by the *made* and the *broken* signals respectively ; therefore it was decided to use the signals sent through Malta, thus practically making Malta into a 'relay' ; the only thing really entering into the Malta reductions affecting the result being the chronometer rate for the short time elapsing between the exchanges with Alexandria and Berlin.

We now give the details of this and the finally adopted longitude of Alexandria ; for this determination certain signals are required which do not appear in the Alexandria-Malta longitude.

The signals given below were exchanged between Alexandria and Malta, and—exactly as in the other determinations—the deduced sidereal times, both at Alexandria and Malta, placed side by side so as to furnish immediately the difference of longitude sought.

* This personal equation is obtained from :
Löw−Gill . . $-0^{s}\cdot06$
Löw−Becker . . $+0^{s}\cdot15$

† See p. 349 and Chap. XVIII.

1875, MARCH 13

SET 12 *a*

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *sent*			Corresponding Malta sidereal time; signals *received*			Resulting longitude, Alexandria east of Malta		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	13	40	10·3	13	20	6·90	12	18	36·58	1	1	30·32
2			21·0			17·60			46·70			30·90
3			51·0			47·60		19	17·29			30·31
4		41	2·2			58·80			28·12			30·68
5			21·0		21	17·60			46·87			30·73
6			30·7			27·30			56·91			30·39
7			51·7			48·30		20	17·76			30·54
8		42	1·3			57·90			26·99			30·91
9			11·6		22	8·20			37·92			30·28
10			20·7			17·30			46·94			30·36
11			31·7			28·30			57·87			30·43
12			51·4			48·00		21	17·23			30·77
13		43	1·0			57·60			27·25			30·35
14			11·7		23	8·30			37·68			30·62
15			21·2			17·80			47·21			30·59
16			31·7			28·30			57·74			30·56
17		44	21·0		24	17·61		22	47·27			30·34
18			31·3			27·91			57·40			30·51
19		45	1·2			57·81		23	27·28			30·53
20			11·8		25	8·41			37·51			30·90
21			31·1			27·71			57·06			30·65
22			51·7			48·31		24	17·62			30·69
23		46	1·3			57·91			27·55			30·36
24			11·9		26	8·51			37·87			30·64
25			21·3			17·91			47·60			30·31
26	13	46	31·9	13	26	28·51	12	24	57·73			30·78

SET 12 *b*

Number of signal	Time by chronometer 43			Alexandria sidereal time; signals *received*			Corresponding Malta sidereal time; signals *sent*			Resulting longitude, Alexandria east of Malta		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	13	48	43·5	13	28	40·11	12	27	9·09	1	1	31·02
2			53·7			50·31			19·31			31·00
3		49	13·6		29	10·21			39·27			30·94
4			23·9			20·52			49·90			30·62
5			53·8			50·42		28	19·28			31·14
6		50	13·8		30	10·42			39·33			31·09
7			24·2			20·82			49·76			31·06
8			33·7			30·32			59·39			30·93
9			44·2			40·82		29	9·51			31·31
10			54·3			50·92			19·94			30·98
11		51	24·3		31	20·92			49·83			31·09
12			33·3			29·92			59·45			30·47
13			54·3			50·92		30	19·81			31·11
14		52	14·4		32	11·02			40·16			30·86
15			25·0			21·62			50·69			30·93
16			34·0			30·62			59·42			31·20
17			44·0			40·62		31	9·74			30·88
18		53	34·0		33	30·62			59·39			31·23
19			44·3			40·92		32	9·92			31·00
20		54	13·9		34	10·52			39·30			31·22
21			24·2			20·82			49·93			30·89
22			35·0			31·63		33	0·56			31·07
23			44·2			40·83			10·18			30·65
24	13	54	54·0	13	34	50·63	12	33	19·31			31·32

Taking the means of the preceding we have the difference of longitude :—

	Alexandria east of Malta h.	m.	s.
By signals sent from Alexandria and recorded at Malta	1	1	30·556
„ Malta „ Alexandria			31·000

Combining this with the other results on page 319, we have :—

	h.	m.	s.
March 10, Alexandria east of Malta	1	1	30·595
„ 11 „ „			30·765
„ 12 „ „			30·701
„ 13 „ „			30·778
„ 14 „ „			30·726
Mean	1	1	30·713
Correction for personal equation between Dr. Löw and Mr. Gill* in observing transits			−0·06
Correction for personal equation between Dr. Löw and Mr. Gill* in recording signals			+0·015
	1	1	30·668
Malta east of Berlin (see next chapter)	0	4	28·245

Therefore, finally, we have adopted :—

	h.	m.	s.
Alexandria east of Berlin	1	5	58·91

Personal Equation between Dr. Löw and Mr. Gill in determining the time with their respective Instruments.

On 1875, March 3, another and last determination of the difference of personal equation between Dr. Löw observing with his transit instrument and Mr. Gill with the altazimuth was made. The instruments were mounted in the same meridian on cemented brick pillars on the roof of the Hôtel de l'Europe. After it had been discovered to what a considerable amount the roof was affected by the weight of the observer, Dr. Löw, when observing, caused his attendant to stand on the opposite side of the instrument, and thus maintain an approximate equilibrium.

From the time determinations previously given, we get :—

For Dr. Löw with the transit instrument and chronometer Nieberg.

Date	Epoch by chronometer	Chronometer correction to local sidereal time	Adopted *hourly* chronometer rate
	h. m. s.	h. m. s.	s.
1875, March 3, 1st group	11 11 0·00	−3 3 33·19	+9·955
„ „ 3, 2nd group	14 44 0·00	−3 2 57·85	

For Mr. Gill with the altazimuth and chronometer 43.

Date	Epoch by chronometer	Chronometer correction to local sidereal time	Adopted *hourly* chronometer rate
	h. m.	h. m. s.	s.
1875, March 3, 1st group	8 24	−0 20 22·22	+0·011
„ „ 3, 2nd group	12 2	−0 20 22·18	

Taking the mean of the separate groups of chronometer comparisons, we have :—

(Nieberg)	(43)
h. m. s.	h. m. s.
13 37 12·46	10 54 25·79

Whence, on applying the chronometer corrections, we find :—

	h.	m.	s.
Dr. Löw with chronometer Nieberg makes the local sidereal time	10	34	3·53
Mr. Gill „ (43) „ „	10	34	3·60

Or—

	s.	
Dr. Löw − Mr. Gill	= −0·07	at Alexandria
„ „	−0·10	at Suez †
„ „	−0·01	at Suez †

* Details of these determinations will be found in Chap XIV. and p. 349.
† See p. 249.

Therefore the final difference of personal equation to be applied to chronometer corrections is:—

Löw − Gill . . . . = −0ˢ·06

Difference of Personal Equation between Mr. Gill observing with Dr. Löw's Transit Instrument and the Troughton and Simms' Altazimuth.

From the results of Mr. Gill's time determinations with Dr. Löw's transit instrument and the altazimuth on March 3, 1875, previously given, we find:—

Mr. Gill observing—

	h.	m.	s.
With Dr. Löw's transit makes correction of (43) to local sidereal time . . .	−0	22	22·17
With the altazimuth " " . " "	−0	22	22·20

Therefore—

Altazimuth − transit . . . . . = −0ˢ·03

Further observations for ascertaining this equation were subsequently taken at Dun Echt. The result for this day has been carried to Chapter XIX., where the final result is deduced.

CHAPTER XVII.

OPERATIONS AT MALTA.

THE observations at Malta were made by Dr. Löw to determine the corrections of the chronometer used in the exchanges of telegraphic longitude signals with Alexandria and Berlin. We proceed to give full details of these observations, and also of the resulting difference of longitude between Malta and Berlin.

OBSERVER, DR. LÖW; CHRONOMETER NIEBERG.

Date, 1875	Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of transit over wire VI.			Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII	IX.	X.	XI.				E	W
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Mar. 10	Drac. 1 H.	E	...	...	...	...	...	...	15·3	46·8	17·5	21·0	55·3*	12	56	11·26	−19·2	−44·3
																	+16·4	+41·3
	„ „	W	...	...	...	...	...	...	...	38·2	7·0	4·0	30·0			13·68	−20·5	−45·4
																	+15·9	+41·0
	f Leonis †	„	29·5	...	...	57·3	...	11·2	...	24·9	...	39·1	53·3	13	13	11·25	+16·0	+41·2
																	−22·5	−47·6
	μ Leonis	„	54·8	8·4	...	21·9	...	35·3	...	48·6	...	2·1	15·8	13	22	35·30	−22·6	−47·7
																	+16·2	+41·3
	Piazzi IX. 230	„	6·1	19·0	...	31·9	...	45·1	...	58·1	...	11·2	24·3	13	32	45·12	...	...
	Piazzi IX. 254	„	31·7	47·9	58·2	...	9·2	19·9	30·8	...	41·2	51·9	8·2	13	40	19·90	−21·8	−46·9
																	+16·0	+41·2
	Camelop. 30 H.	„	...	16·2	24·5	58·1	31·5	...	...	...	...	...	...	13	52	39·80	+16·9	+42·1
																	−19·9	−45·1
	„ „	E	42·1	0·0	52·3	18·8	45·0	...	...	...	...	...	...			36·82	+17·7	+42·8
																	−19·3	−44·5
	33 Leonis min.	„	[17·3‡]	[3·4‡]	...	49·4	...	34·9	...	20·5	...	6·0	51·3	14	1	34·76	...	...
	[42 Leonis min.§	„	24·8	10·3	...	56·2	...	42·3	...	28·2	...	14·0	0·1	14	15	42·21]	−20·2	−45·3
																	+18·6	+43·8
	46 Leonis min.	„	49·1	34·0	...	19·7	...	4·9	...	50·3	...	35·8	20·9	14	23	4·93	+17·4	+42·4
																	−19·1	−44·3
	Bradley 1508	„	43·8	43·2	3·0	43·0	23·2	42·8	...	...	...	...	...	14	26	42·94	−19·1	−44·6
																	+15·8	+41·0
Mar. 10	τ Coronæ	E	1·2	46·3	36·2	...	26·7	16·3	6·4	...	56·2	46·1	31·2	19	40	16·28	+17·9	+43·0
																	−19·8	−44·9
	υ Coronæ	„	17·0	3·1	...	49·2	...	35·3	...	22·0	...	...	...	19	47	35·35	...	...
	α Scorpii	W	54·4	8·1	...	21·2	...	35·0	...	48·2	...	1·8	15·8	19	57	34·95	+15·6	+40·7
																	−20·8	−45·9
	σ Herculis	„	...	...	...	...	...	[56·2‖]	...	...	14·1	25·2	41·8	20	5	52·45	...	...
	Groom. 2373	„	...	...	33·5	53·0	12·2	49·2¶	27·2	...	4·1	41·5	38·3	20	11	49·17	−21·5	−46·5
																	+17·1	+42·2
	χ Ophiuchi	„	53·4	5·5	...	17·7	...	29·9	...	42·2	...	54·3	6·8	20	27	30·00	+16·0	+41·1
																	−20·6	−45·5

* This wire has been increased 1ˢ in accordance with observer's note.
† Star very faint.
[‡] These wires have been rejected, as indicated by observer.
[§] Star rejected; observer noting uncertainty of ½ˢ.
[‖] This wire discordant; rejected.
¶ This wire has been decreased 1ˢ in accordance with observer's note; star extraordinarily faint.

OBSERVER, DR. LÖW; CHRONOMETER NIEBERG (*continued*).

Date, 1875	Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of transit over wire VI.			Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.				E	W
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Mar. 11	η Cancri	W	2·5	15·4	...	28·4	...	41·4	...	54·2	...	7·2	20·1	11	58	41·34	−22·8	−46·1
																	+16·0	+39·6
	39 Cancri	„	27·8	40·4	...	53·2	...	6·1	...	19·2	...	31·9	44·9	12	6	6·24	+15·5	+39·0
																	−23·8	−47·3
	ι Cancri	„	36·8	50·4	...	4·4	...	18·2	...	32·0	...	45·9	59·5	12	12	18·20	−22·0	−45·4
																	+14·8	+38·5
	76 Drac. S.P.	„	54·0	...	...	...	...	...	33·1	5·0	35·5	...	10·3	12	24	31·72	−22·2	−46·1
																	+16·1	+40·1
	τ Cancri	„	54·6	8·7	...	22·2	...	36·4	...	50·2	...	4·2	18·3	12	33	36·40	+14·8	+38·8
																	−23·3	−47·3
	Drac. 1 H.	„	59·0	24·0	21·0	50·0	17·0	...	...	...	...	...	...	12	52	14·79	−21·4	−45·3
																	+14·6	+38·8
	„ „	E	31·0	6·0	8·3	40·2	12·2	...	...	...	...	...	...			14·95	−22·0	−46·2
																	+16·3	+40·7
	f Leonis	„	56·5	42·5	...	28·6	...	14·6	...	0·6	...	...	32·7	13	9	14·56	+15·8	+40·2
																	−20·8	−45·2
	μ Leonis	„	19·4	5·7	...	52·2	...	38·3	...	25·4	...	...	58·4	13	18	38·72	−21·9	−46·2
																	+15·4	+39·7
	Piazzi IX. 230	„	...	14·5	...	1·7	...	48·7	...	35·5	...	22·5	9·2	13	28	48·52	+15·8	+40·2
																	−21·9	−46·3
	Piazzi IX. 254	„	11·6	55·5	44·8	...	34·2	23·2	12·8	...	2·2	51·2	35·3	13	36	23·41	−21·6	−46·2
																	+15·5	+40·2
	24 Cephei S.P.	„	...	...	...	...	...	14·3	40·0	52·5	6·0	31·5	9·4	13	40	14·46	...	...
	Camelop. 30 H.	„	...	...	...	...	...	41·4*	33·0	1·0	26·0	18·2	...	13	48	41·34	+14·3	+39·0
																	−21·8	−46·4
Mar. 12	ϕ^1 Cancri	E	49·4	35·7	...	21·7	...	8·4	...	54·4	...	40·5	27·1	11	48	8·15	+18·3	+41·2
																	−20·0	−42·9
	η Cancri	„	23·2	10·2	...	57·3	...	44·4	...	31·6	...	18·7	5·7	11	54	44·42	−20·2	−43·3
																	+17·4	+40·4
	39 Cancri	„	...	35·2	...	22·3	...	9·4	...	56·7	...	43·6	30·6	12	2	9·37	+17·2	+40·4
																	−19·3	−42·8
	ι Cancri	„	2·5	48·9	...	35·0	...	21·2	...	7·2	...	53·6	39·8	12	8	21·15	...	...
	76 Drac. S.P.	„	...	...	41·5	10·0	39·2	...	...	...	...	...	...	12	20	37·57	−19·9	−43·6
																	+16·0	+39·8
	„ „	W	57·3	30·5	[32·5†]	...	35·0	...	...	...	...	...	...			35·96	−20·3	−44·2
																	+15·0	+39·0
	36 Lyncis	„	56·9	13·7	...	30·3	...	47·1	...	3·7	...	20·1	37·0	12	34	47·00	+15·3	+39·5
																	−21·3	−45·3
	α Lyncis	„	...	...	...	19·4	...	34·8	...	49·2	...	4·0	18·9	12	42	34·60	...	...
	10 Leonis min.	„	...	...	[19·1‡]	...	29·9	39·9	50·0	...	0·0	10·0	25·1	12	55	39·92	−19·9	−44·1
																	+15·0	+39·2
	f Leonis	„	36·2	50·0	...	4·1	...	18·1	...	32·1	...	46·0	0·1	13	5	18·11	+15·4	+39·7
																	−20·2	−44·5
	μ Leonis	„	1·8	15·3	...	29·0	...	42·2	...	55·2	...	9·1	22·8	13	14	42·22	−19·4	−43·7
																	+15·2	+39·6
	Piazzi IX. 230	E	31·0	17·9	...	4·8	...	51·8	...	38·9	...	25·6	12·2	13	24§	51·72	−18·5	−42·9
																	+16·6	+40·9
	Piazzi IX. 254	„	14·2	...	...	42·3	...	26·3	...	10·2	...	54·1	38·2	13	32§	26·20	...	...
	24 Cephei S.P.	„	...	2·3	28·1	...	53·9	20·0	45·3	58·1	11·0	37·0	15·1	13	36	19·74	+16·9	+41·3
																	−19·8	−44·3
	Camelop. 30 H.	„	...	3·2	56·1	22·8	49·0	40·2	32·8	0·0	25·0	17·2	...	13	44	40·51	−19·9	−44·3
																	+17·3	+41·8
Mar. 12	β Ursæ min.	E	33·5	47·6	17·5	2·5	47·3	17·0	46·1	31·5	16·0	45·8	0·0	18	19	16·73	+16·2	+41·4
																	−20·2	−45·3
	β Boötis	„	13·1	57·2	...	41·1	...	25·2	...	9·3	...	53·3	37·4	18	25	25·20	−18·8	−43·9
																	+17·2	+42·3
	δ Boötis	„	20·0	5·1	...	51·2	...	36·7	...	22·1	...	7·3	53·1	18	38	36·47	+18·1	+43·2
																	−18·2	−43·4
	α Coronæ	W	48·9	2·2	...	15·8	...	29·9	...	43·2	...	56·8	10·1	18	57	29·58	+15·9	+41·1
																	−18·8	−44·0

* This wire has been decreased 1^s in accordance with observer's note.
[‡] This wire discordant; rejected.
[†] Uncertainty of 1^s in this wire; music; not used.
§ Minute supplied.

OBSERVER, DR. LÖW; CHRONOMETER NIEBERG (*continued*).

Date, 1875	Name of star	Position of circle	Seconds of transit over the wires I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	Concluded chronometer time of transit over wire VI. h.	m.	s.	Level readings E p.	W p.
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.					
Mar. 12 (*cont.*)	δ Coronæ	W	44·2	57·1	...	11·0	...	24·4	...	38·0	...	51·4	5·0	19	12	24·47	−18·1	−43·3
																	+15·8	+41·0
	λ Coronæ	„	30·6	46·0	56·5	...	...	16·8	...	32·0	...	47·4	2·9	19	19	16·78	+15·8	+41·1
																	−18·6	−43·7
	Groom. 750 S.P.	„	...	...	...	...	...	...	23·0	35·8	46·5	...	...	19	25	59·44	...	...
	„ „	E	...	...	...	...	...	...	41·5	29·0	17·5	...	...		26	4·99	...	...
	τ Coronæ	„	8·1	53·2	...	38·17	...	23·3	...	...	3·2	53·0	38·1	19	32	23·14	−18·2	−43·6
																	+16·5	+41·8
	υ Coronæ	„	23·8	...	...	56·4	...	42·4	...	28·8	...	14·9	0·8	19	39	42·44	+17·9	+43·2
																	−17·8	−43·1
Mar. 14	α Libræ	E	57·4	44·5	...	32·5	...	19·9	...	7·5	...	54·8	42·3	18	4	19·82	...	...
	β Ursæ min.	„	40·2	54·8	24·2	9·2	54·5	23·2	53·2	38·4	23·0	52·5	6·8	18	11	23·56	−20·2	−45·1
																	+16·0	+40·8
	β Boötis	„	20·7	4·8	54·1	...	43·2	32·9	22·1	...	11·2	1·0	45·0	18	17	32·76	+16·0	+40·8
																	−19·2	−44·1
	δ Boötis	W	1·2	15·1	...	30·0	...	44·8	...	59·1	...	13·7	28·2	18	30*	44·61	+14·8	+39·6
																	−20·5	−45·2
	β Coronæ	„	13·2	27·5	...	41·4	...	55·2	...	9·2	...	23·0	37·0	18	42	55·24	−19·1	−44·0
																	+16·9	+41·8
	α Coronæ	„	56·9	10·4	...	24·0	...	37·2	...	51·0	...	4·4	18·2	18	49†	37·47	+16·1	+41·3
																	−20·3	−45·3
	δ Coronæ	„	51·9	5·3	...	18·9	...	32·2	...	45·5	...	59·2	13·0	19	4	32·31	−19·9	−45·0
																	+15·9	+49·0
	ζ Ursæ min.	„	...	...	...	...	2·3	42·0	21·1	40·0	0·2	39·2	...	19	8	41·84	...	...
	Groom. 750 S.P.	„	...	...	...	...	...	...	35·0	48·0	57·5	22·5	...	19	18	11·38	+16·9	+42·0
																	−19·6	−44·6
	„ „	E	...	...	...	...	...	...	[53·8‡]	38·5	28·0	5·3	30·5			15·39	+17·4	+42·4
																	−20·4	−45·4
Mar. 15	33 Leonis min.	E	36·2	22·0	...	7·7	...	53·1	...	...	...	24·2	10·0	13	41	53·13	−19·9	−44·8
																	+15·4	+40·3
	37 Comæ	„	43·0	29·1	...	14·7	...	0·7	...	46·9	...	32·1	18·2	16	11	0·64	+15·7	+41·2
																	−20·3	−45·8
	α Ursæ min. S.P.	„	...	...	57·5	44·8	33·5	...	...	...	...	...	...	16	29	15·92	−19·5	−44·9
																	+15·0	+40·3
	„ „	W	...	...	...	33·6	...	1·5	...	...	...	...	...			2·15	−20·0	−45·4
																	+14·9	+40·2
	Canum ven. 17 H.	„	4·9	...	30·2	...	40·4	50·9	...	...	11·1	21·2	36·3	16	45§	50·68	+13·7	+39·0
																	−21·4	−46·8
	ε Boötis	„	44·4	57·5	...	...	...	23·2	...	36·2	...	49·3	2·1	17	0	23·31	...	...
	η Boötis	„	40·2	...	...	5·2	...	...	...	31·1	...	44·0	...	17	5	18·36	−20·3	−45·7
																	+14·6	+39·8
	[A. Boötis ‖	„	42·6	58·2	...	13·2	...	28·2	...	42·4	...	57·2	...	17	29	12·37]	−18·8	−44·1
																	+16·4	+41·6

* 50m in original. † Minute supplied. [‡] This wire rejected in accordance with observer's note.
§ 46m in original. ‖ Star rejected; observer's note ambiguous.

The observations were all taken by Dr. Löw with the same instrument and chronometer as were used at Suez. They have, therefore, been reduced in exactly the same manner as the observations at that place.

Levellings.

1875, MARCH 10.

1st Group.

E p.	W p.
−1·45	−2·25
−0·82	−3·22
−0·78	−3·20
−0·90	−2·8
−1·72	−1·5

Mean level p. −1·87

	p.	s.
E	−1·72	= −0·191
W	−2·02	= −0·224

2nd Group.

E p.	W p.
−0·95	−2·60
	−2·18
	−2·25

Mean level p. −1·84

	p.	s.
E	−1·69	= −0·188
W	−1·99	= −0·221

1875, March 11.

E	W
p.	p.
−2·80	−3·32
−2·50	−4·15
−3·25	−3·52
−3·05	−3·02
−3·02	−4·25
−3·72	−3·38

Mean level p. −3·33

	p.	s.
E	−3·18	= −0·353
W	−3·48	= −0·386

1875, March 12.

1st Group.

E	W
p.	p.
−0·85	−2·62
−1·42	−2·95
−1·12	−2·45
−1·92	−2·40
−0·98	−2·08
−1·48	
−1·28	

Mean level p. −1·90

	p.	s.
E	−1·75	= −0·194
W	−2·05	= −0·228

2nd Group.

E	W
p.	p.
−1·98	−1·45
−0·80	−1·15
−0·08	−1·35
−0·88	
+0·05	

Mean level p. −1·03

	p.	s.
E	−0·88	= −0·098
W	−1·18	= −0·131

1875, March 14.

E	W
p.	p.
−2·12	−2·82
−1·62	−1·10
−1·50	−2·10
	−1·32

Mean level p. −1·79

	p.	s.
E	−1·64	= −0·182
W	−1·94	= −0·215

1875, March 15.

E	W
p.	p.
−2·25	−2·58
−2·30	−3·88
−2·28	−2·90
	−1·22

Mean level p. −2·46

	p.	s.
E	−2·3	−0·256
W	−2·61	= −0·290

Corrections for Collimation and Azimuth.

Date	Collimation, circle W	Azimuth
	s.	s.
1875, March 10, 1st group	−0·163	−0·903
„ „ 2nd group	„	−1·005
„ March 11	+0·023	−1·108
„ March 12, 1st group	−0·104	−1·454
„ „ 2nd group	−0·223	−1·277
„ March 14	−0·159	−1·752
„ March 15	−0·153	−1·437

The application of these corrections and the results from each star are shown in the next table :—

OBSERVER, DR. LÖW; CHRONOMETER NIEBERG.

Date, 1875	Epoch by chronometer and assumed *hourly* chronometer rate	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Chronometer rate to epoch	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m. s.			h. m. s.	s.	s.	h. m. s.	h. m. s.
Mar. 10, 1st group	13 47 0·00	Drac. 1 H.	E	12 56 11·26	−8·39	+4·81	9 19 17·36	[−3 36 50·30]
	s.	„ „	W	13·68	−8·38	+2·35	„	
	+9·902	*f* Leonis	„	13 13 11·25	−5·59	−0·55	9 36 15·40	−3 36 49·71
		μ Leonis	„	13 22 35·30	−4·03	−0·59	9 45 40·93	49·75
		Piazzi IX. 230	„	13 32 45·12	−2·35	−0·65	9 55 52·46	49·66
		Piazzi IX. 254	„	13 40 19·90	−1·11	−0·41	10 3 28·82	49·56
		Camelop. 30 H.	„	13 52 39·80	+0·93	+2·94	10 15 54·64	[49·01]
		„ „	E	36·82	+0·92	+5·89	„	
		33 Leonis min.	„	14 1 34·76	+2·41	−0·09	10 24 47·54	49·54
		[42 Leonis min.	„	14 15 42·21	+4·74	−0·11	10 38 56·74	50·10]
		46 Leonis min.	„	14 23 4·93	+5·96	−0·05	10 46 21·21	49·63
		Bradley 1508	„	14 26 42·94	+6·55	+3·16	10 50 3·03	[49·62]
	h. m. s.							
Mar. 10, 2nd group	20 0 0·00	*τ* Coronæ	E	19 40 16·28	−3·25	−0·01	16 4 25·11	−3 35 47·91
	s.	*υ* Coronæ	„	19 47 35·45	−2·05	−0·15	16 11 45·23	48·02
	+9·902	*α* Scorpii	W	19 57 34·95	−0·40	−1·29	16 21 45·31	47·95
		σ Herculis	„	20 5 52·45	+0·97	−0·36	16 30 5·23	47·83
		Groom. 2373	„	20 11 49·17	+1·95	+1·61	16 36 4·75	[47·98]
		κ Ophiuchi	„	20 27 30·00	+4·54	−0·82	16 51 45·54	48·18
	h. m. s.							
Mar. 11	12 48 0·00	*η* Cancri	W	11 58 41·34	−8·12	−0·68	8 25 30·15	−3 33 2·39
	s.	39 Cancri	„	12 6 6·24	−6·89	−0·69	8 32 56·27	2·39
	+9·878	*ι* Cancri	„	12 12 18·20	−5·87	−0·56	8 39 9·46	2·31
		76 Drac. S.P.	„	12 24 31·72	−3·87	−5·94	20 51 19·96	[1·95]
		τ Cancri	„	12 33 36·40	−2·37	−0·54	9 0 31·48	2·01
		Drac. 1 H.	„	12 52 14·79	+0·70	+3·90	9 19 17·30	[2·09]
		„ „	E	14·95	+0·70	+3·74	„	
		f Leonis	„	13 9 14·56	+3·50	−0·56	9 36 15·39	2·11
		μ Leonis	„	13 18 38·72	+5·04	−0·62	9 45 40·93	2·21
		Piazzi IX. 230	„	13 28 48·52	+6·71	−0·67	9 55 52·46	2·10
		Piazzi IX. 254	„	13 36 23·41	+7·97	−0·36	10 3 28·82	2·20
		24 Cephei S.P.	„	13 40 14·46	+8·60	−2·96	22 7 18·59	[1·51]
		Camelop. 30 H.	„	13 48 41·34	+9·99	+4·67	10 15 54·61	[1·39]
	h. m. s.							
Mar. 12, 1st group	12 40 0·00	ϕ^1 Cancri	E	11 48 8·15	−8·55	−0·32	8 18 52·98	−3 29 6·30
	s.	*η* Cancri	„	11 54 44·42	−7·46	−0·49	8 25 30·14	6·33
	+9·892	39 Cancri	„	12 2 9·37	−6·24	−0·50	8 32 56·26	6·37
		ι Cancri	„	12 8 21·15	−5·22	−0·29	8 39 9·45	6·19
		76 Drac. S.P.	„	12 20 37·57	−3·19	−9·39	20 51 20·06	[4·92]
		„ „	W	35·96	−3·20	−7·78	„	
		36 Lyncis	„	12 34 47·00	−0·85	−0·18	9 5 39·53	6·44
		α Lyncis	„	12 42 34·60	+0·42	−0·44	9 13 28·13	6·45
		10 Leonis min.	„	12 55 39·92	+2·58	−0·39	9 26 35·73	6·38
		f Leonis	„	13 5 18·11	+4·18	−0·54	9 6 15·39	6·36
		μ Leonis	„	13 14 42·22	+5·72	−0·63	9 45 40·92	6·39
		Piazzi IX. 230	E	13 24 51·72	+7·40	−0·45	9 55 52·46	6·21

OBSERVER, DR. LÖW; CHRONOMETER NIEBERG (*continued*).

Date, 1875	Epoch by chronometer and assumed *hourly* chronometer rate	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Chronometer rate to epoch	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m. s.			h. m. s.	s.	s.	h. m. s.	h. m. s.
Mar. 12, 1st group (*cont.*)	12 40 0·00	Piazzi IX. 254	E	13 32 26·20	+ 8·64	+ 0·06	10 3 28·81	−3 29 6·09
	s.	24 Cephei S.P.	„	13 36 19·74	+ 9·28	− 4·56	22 7 18·62	[5·84]
	+9·892	Camelop. 30 H.	„	13 44 40·51	+10·66	+ 8·79	10 15 54·57	[5·39]
	h. m. s.							
Mar. 12, 2nd group	19 6 0·00	β Ursæ min.	E	18 19 16·73	− 7·71	+ 3·57	14 51 9·98	[−3 28 2·61]
	s.	β Boötis	„	18 25 25·20	− 6·69	+ 0·32	14 57 15·90	−3 28 2·93
	+9·892	δ Boötis	„	18 38 36·47	− 4·52	+ 0·09	15 10 29·26	2·78
		α Coronæ	W	18 57 29·58	− 1·41	− 0·62	15 29 24·91	2·64
		δ Coronæ	„	19 12 24·47	+ 1·05	− 0·62	15 44 22·17	2·73
		λ Coronæ	„	19 19 16·78	+ 2·19	− 0·38	15 51 15·94	2·65
		Groom. 750 S.P.	„	19 25 59·44	+ 3·29	− 9·66	3 57 50·46	[2·62]
		„ „	E	26 4·99	+ 3·31	−15·22	„	
		τ Coronæ	„	19 32 23·14	+ 4·35	+ 0·19	16 4 25·17	2·51
		υ Coronæ	„	19 39 42·44	+ 5·56	− 0·02	16 11 45·28	2·70
	h. m. s.							
Mar. 14	18 35 0·00	α Libræ	E	18 4 19·82	− 5·05	− 1·38	14 43 59·04	−3 20 14·35
	s.	β Ursæ min.	„	18 11 23·56	− 3·89	+ 4·21	14 51 10·11	[13·77]
	+9·868	β Boötis	„	18 17 32·76	− 2·87	+ 0·17	14 57 15·95	14·11
		δ Boötis	W	18 30 44·61	− 0·70	− 0·53	15 10 29·31	14·07
		β Coronæ	„	18 42 55·24	+ 1·30	− 0·65	15 22 41·87	14·02
		α Coronæ	„	18 49 37·47	+ 2·40	− 0·72	15 29 24·96	14·19
		δ Coronæ	„	19 4 32·31	+ 4·86	− 0·74	15 44 22·22	14·21
		ζ Ursæ min.	„	19 8 41·84	+ 5·55	+ 4·19	15 48 37·97	[13·61]
		Groom. 750 S.P.	„	19 18 11·38	+ 7·10	−14·78	3 57 50·01	[13·69]
		„ „	E	15·39	+ 7·12	−18·81	„	
	h. m. s.							
Mar. 15	16 22 0·00	33 Leonis min.	E	13 41 53·13	−26·35	− 0·22	10 24 47·53	−3 16 39·03
	s.	37 Comæ	„	16 11 0·64	− 1·81	− 0·25	12 54 19·51	39·07
	+9·876	α Ursæ min. S.P.	„	16 29 15·92	+ 1·19	−50·43	1 11 47·64	[39·04]
		„ „	W	2·15	+ 1·16	−36·63	„	
		Canum ven. 17 H.	„	16 45 50·68	+ 3·92	− 0·50	13 29 14·92	39·18
		ε Boötis	„	17 0 23·31	+ 6·32	− 0·84	13 43 49·91	38·88
		η Boötis	„	17 5 18·36	+ 7·12	− 0·89	13 48 45·58	39·01

Taking the means of the separate groups, we get the following chronometer corrections :—

WITH DR. LÖW'S TRANSIT INSTRUMENT.

Observer, Dr. Löw; Chronometer Nieberg.

Date	Epoch by chronometer h. m. s.	Chronometer correction to local sidereal time		h. m. s.	h. m. s.
1875, March 10, 1st group .	. 13 47 0·00	Circle E	−3 36	49·585	−3 36 49·63
		„ W		49·670	
„ March 10, 2nd group	. 20 0 0·00	Circle E	−3 35	47·965	−3 35 47·98
		„ W		47·987	
„ March 11 . .	. 12 48 0·00	Circle E	−3 33	2·155	−3 33 2 22
		„ W		2·275	
„ March 12, 1st group .	. 12 40 0·00	Circle E	−3 29	6·248	−3 29 6·33
		W		6·404	

WITH DR. LÖW'S TRANSIT INSTRUMENT (*continued*).

Date	Epoch by chronometer h. m. s.		Chronometer correction to local sidereal time h. m. s.		h. m. s.
1875, March 12, 2nd group .	19 6 0·00	Circle E	−3 28 2·730	−3 28 2·70	
		„ W	2·673		
„ March 14	18 35 0·00	Circle E	−3 20 14·230	−3 20 14·18	
		„ W	14·122		
„ March 15	16 22 0·00	Circle E	−3 16 39·050	−3 16 39·04	
		„ W	39·023		

These corrections have been used to obtain the Malta sidereal times of the longitude signals on the respective days. On March 10 an *hourly* rate of $+9^{s}\cdot916$ has been used; on March 12 an *hourly* rate of $+9^{s}\cdot891$. These rates are obtained from the two separate groups of observations on these nights. For the other days a rate of $+9^{s}\cdot903$ per *hour* has been used—the mean of these two determinations.

SIGNALS SENT TO AND RECEIVED FROM ALEXANDRIA.

The following are the chronometer and local sidereal times of despatch and receipt of signals to and from Alexandria. In anticipation of the data on which they are based, the Malta sidereal times have already been given in Chapter XVI. along with the observed Alexandria times and the resulting difference of meridians:—

1875, MARCH 10

Number of signal	SET 1	SET 2	SET 3	SET 4
	Time by chronometer Nieberg	Time by chronometer Nieberg	Time by chronometer Nieberg	Time by chronometer Nieberg
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	16 45 34·0	16 56 20·0	17 7 20·0	17 17 14·0
2	44·0	30·0	40·0	24·9
3	46 4·2	40·0	8 10·0	34·9
4	34·0	50·0	20·0	44·2
5	44·0	57 20·0	30·0	18 14·7
6	47 25·0	30·0	40·0	23·9
7	34·0	40·0	9 10·0	34·2
8	48 4·4	50·0	20·0	44·3
9	14·2	58 10·0	40·0	19 4·1
10	24·8	20·0	50·0	14·2
11	34·9	30·0	10 10·0	24·6
12	44·9	40·0	50·0	44·0
13	49 4·7	50·0	11 10·0	20 4·0
14	15·0	59 10·0	30·0	14·1
15	24·9	20·0	40·0	34·0
16	34·1	40·0	50·0	44·9
17	50 4·2	50·0	12 10·0	21 4·5
18	14·0	17 0 10·0	30·0	24·1
19	24·3	20·0	40·0	22 4·0
20	34·7	30·0	50·0	14·0
21	44·7	40·0	14 40·0	24·9
22	51 4·1	50·0	50·0	44·0
23	14·0	1 10·0	15 20·0	23 24·8
24	24·8	20·0	30·0	34·9
25	34·5	30·0	40·0	44·0
26	44·0	40·0	17 15 50·0	24 4·3
27	52 4·7	50·0	...	34·0
28	14·2	2 10·0	...	25 4·0
29	24·4	20·0	...	14·0
30	34·2	30·0	...	24·5
31	53 4·7	3 10·0	...	34·9
32	14·9	20·0	...	26 4·7
33	24·9	4 40·0	...	24·3
34	35·0	50·0	...	44·0
35	44·9	5 10·0	...	27 4·0
36	54 4·3	20·0	...	14·0
37	14·7	30·0	...	17 27 45·0
38	35·0	17 5 40·0	...	...
39	16 54 44·8	...	...	...

SIGNALS SENT TO AND RECEIVED FROM ALEXANDRIA (*continued*).

1875, MARCH 11

Number of signal	SET 5	SET 6	SET 7	SET 8
	Time by chronometer Nieberg	Time by chronometer Nieberg	Time by chronometer Nieberg	Time by chronometer Nieberg
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	16 27 12·0	16 42 20·2	16 53 29·7	17 8 32·7
2	28 31·3	30·5	39·0	41·8
3	42·1	40·0	49·0	9 11·0
4	29 2·0	50·0	54 9·0	22·3
5	12·0	44 30·3	29·2	31·1
6	22·0	39·9	39·0	42·5
7	31·4	49·8	55 29·0	10 1·8
8	42·0	45 9·7	49·0	13·0
9	30 22·2	19·9	56 9·5	21·0
10	31 2·0	29·8	19·0	32·3
11	11·9	39·9	29·0	41·0
12	31·0	50·0	39·8	11 22·6
13	32 0·8	46 19·0	57 29·3	32·0
14	11·0	30·1	58 9·0	43·0
15	22·0	39·0	38·8	12 12·8
16	31·4	48·9	48·9	32·8
17	42·2	47 9·3	59 9·0	13 2·8
18	33 1·3	29·3	19·3	11·0
19	11·2	48 9·8	29·0	33·0
20	21·0	29·5	49·0	42·0
21	32·2	49·5	17 0 9·2	14 11·0
22	42·9	49 9·3	18·7	22·0
23	34 2·0	29·2	29·0	31·0
24	11·1	49·8	38·6	43·0
25	21·2	50 9·5	49·2	15 2·0
26	32·4	19·0	1 39·5	11·0
27	35 1·5	38·9	17 1 49·0	33·0
28	11·6	49·1	...	16 1·0
29	22·2	51 9·8	...	21·0
30	32·0	29·0	...	43·0
31	42·0	38·9	...	17 1·5
32	36 32·9	16 51 49·8	...	10·8
33	41·8	...	...	17 17 31·5
34	37 1·0	...	...	...
35	11·2	...	...	...
36	22·1	...	...	...
37	31·3	...	...	...
38	41·9	...	...	...
39	38 3·0	...	...	...
40	12·2	...	...	...
41	16 38 21·3	...	...	...

SIGNALS SENT TO AND RECEIVED FROM ALEXANDRIA (*continued*).

1875, MARCH 12

Number of signal	SET 9	SET 10	SET 11	SET 12
	Time by chronometer Nieberg	Time by chronometer Nieberg	Time by chronometer Nieberg	Time by chronometer Nieberg
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	15 59 58·2	16 20 15·0	16 27 15·8	16 55 14·9
2	16 0 9·9	25·8	26·0	35·9
3	19·0	44·9	35·0	45·0
4	29·9	54·9	45·0	55·3
5	38·2	21 16·0	55·4	56 16·0
6	58·0	25·2	28 15·1	35·1
7	1 9·0	36·0	25·7	45·8
8	19·2	44·8	35·3	55·4
9	29·8	56·0	45·0	57 15·8
10	38·1	22 26·0	55·2	25·9
11	58·0	35·0	29 16·0	36·0
12	2 8·2	46·0	26·0	55·8
13	18·9	55·0	35·0	58 14·8
14	58·9	23 15·5	44·9	25·8
15	3 10·0	26·0	55·8	45·0
16	19·9	35·0	30 15·0	55·8
17	28·5	45·9	26·0	59 15·8
18	39·9	55·0	34·9	26·0
19	58·8	24 15·0	44·8	35·8
20	4 9·0	25·3	31 15·8	17 0 25·0
21	29·0	36·1	25·0	35·1
22	40·0	16 24 45·0	35·9	45·5
23	58·4	...	45·5	17 0 55·9
24	5 9·0	...	56·0	...
25	20·0	...	32 14·8	...
26	29·0	...	35·0	...
27	16 5 39·0	...	45·0	...
28	...	...	55·5	...
29	...	...	33 15·7	...
30	...	...	26·0	...
31	...	...	34·9	...
32	...	...	45·8	...
33	...	...	16 33 55·8	...

The following signals exchanged between Alexandria and Malta are required for the finally adopted longitude of Alexandria (p. 348), the corresponding Malta sidereal times having, as usual, been given at the Alexandria end (p. 347).

1875, MARCH 13

Number of signal	SET 12*a*		SET 12*b*	
	Time by chronometer Nieberg	Number of signal	Time by chronometer Nieberg	Number of signal	Time by chronometer Nieberg	Number of signal	Time by chronometer Nieberg
	h. m. s.		h. m. s.		h. m. s.		h. m. s.
1	15 43 15·9	14	15 46 16·5	1	15 51 47·0	14	15 55 17·5
2	26·0	15	26·0	2	57·2	15	28·0
3	56·5	16	36·5	3	52 17·1	16	36·7
4	44 7·3	17	47 25·9	4	27·7	17	47·0
5	26·0	18	36·0	5	57·0	18	56 36·5
6	36·0	19	48 5·8	6	53 17·0	19	47·0
7	56·8	20	16·0	7	27·4	20	57 16·3
8	45 6·0	21	35·5	8	37·0	21	26·9
9	16·9	22	56·0	9	47·1	22	37·5
10	25·9	23	49 5·9	10	57·5	23	47·1
11	36·8	24	16·2	11	54 27·3	24	15 57 56·2
12	56·1	25	25·9	12	36·9		
13	15 46 6·1	26	15 49 36·0	13	15 54 57·2		

SIGNALS SENT TO AND RECEIVED FROM ALEXANDRIA (*continued*).

1875, MARCH 14

Number of signal	SET 13	SET 14	SET 15	SET 16
	Time by chronometer Nieberg	Time by chronometer Nieberg	Time by chronometer Nieberg	Time by chronometer Nieberg
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	15 39 53·2	15 55 19·9	16 4 59·0	16 19 23·8
2	40 4·2	30·1	5 19·0	33·7
3	13·2	39·0	29·5	53·0
4	23·0	49·1	39·0	20 3·8
5	43·1	59·5	59·5	13·0
6	53·9	56 19·8	6 19·7	23·9
7	41 3·8	30·5	29·1	33·9
8	13·0	39·0	49·0	21 3·9
9	24·0	49·0	59·1	13·0
10	33·0	59·8	7 20·0	23·9
11	43·0	57 19·7	29·0	53·5
12	53·0	29·0	39·7	22 23·0
13	42 3·0	39·9	49·0	53·0
14	14·0	58 39·7	59·0	23 4·0
15	23·2	49·0	8 20·0	14·0
16	33·3	59·5	29·4	23·2
17	43 3·6	59 19·8	39·0	33·0
18	13·1	29·9	49·0	53·0
19	23·2	39·5	9 0·0	24 3·5
20	33·0	49·0	18·9	13·8
21	44 3·0	59·0	39·8	23·0
22	13·8	16 0 20·0	58·8	33·5
23	24·0	29·1	10 19·5	53·2
24	33·5	39·7	29·1	25 3·8
25	45 3·8	49·0	49·0	13·9
26	13·0	1 29·0	11 19·5	23·0
27	33·5	39·8	49·0	34·0
28	46 3·0	49·0	59·5	53·8
29	13·0	59·5	12 19·3	26 3·5
30	23·9	2 29·3	29·8	13·5
31	33·9	39·0	39·2	23·0
32	47 3·5	49·1	48·9	33·3
33	13·9	59·6	59·1	53·1
34	23·8	3 19·9	13 19·7	27 3·2
35	33·5	29·0	29·0	16 27 13·5
36	48 3·5	39·0	38·9	...
37	14·1	59·5	49·2	...
38	24·2	4 20·2	14 20·2	...
39	33·1	39·5	39·0	...
40	53·2	16 4 49·0	49·0	...
41	49 4·0	...	16 14 59·2	...
42	34·0	...	...	...
43	53·2	...	...	...
44	50 14·1	...	...	...
45	34·0	...	...	...
46	53·9	...	...	...
47	51 4·0	...	...	...
48	13·0	...	...	...
49	24·0	...	...	...
50	34·0	...	...	...
51	15 51 53·1	...	...	...

Malta-Berlin Longitude.

The next table contains the times by the chronometer at Malta and the local sidereal times of signals exchanged between Malta and Berlin. The Berlin figures are given in advance of the observations from which they are derived, to permit of the immediate deduction of the difference of meridians.

1875, March 10

Set 1: Morse*

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 50 0·0	11 13 20·78	11 8 52·57	0 4 28·21
2	10·0	30·81	9 2·77	28·04
3	20·0	40·84	12·77	28·07
4	30·0	50·86	22·67	28·19
5	40·0	14 0·89	32·81	28·08
6	51 10·0	30·97	10 2·86	28·11
7	20·0	41·00	12·86	28·14
8	30·0	51·03	22·86	28·17
9	40·0	15 1·06	32·91	28·15
10	50·0	11·08	42·96	28·12
11	52 1·0	22·11	53·00	[29·11†]
12	20·0	41·17	11 13·05	28·12
13	40·0	16 1·23	33·05	28·18
14	50·0	11·26	43·15	28·11
15	53 1·0	22·29	53·05	[29·24†]
16	10·0	31·31	12 3·15	28·16
17	20·0	41·34	13·09	28·25
18	30·0	51·37	23·19	28·18
19	40·0	17 1·40	33·34	28·06
20	50·0	11·42	43·34	28·08
21	54 1·0	22·45	53·44	[29·01†]
22	10·0	31·48	13 3·44	28·04
23	20·0	41·50	13·34	28·16
24	30·0	51·53	23·39	28·14
25	40·0	18 1·56	33·38	28·18
26	50·0	11·59	43·43	28·16
27	55 1·0	22·62	53·48	[29·14†]
28	10·0	31·64	14 3·48	28·16
29	20·0	41·67	13·53	28·14
30	30·0	51·70	23·53	28·17
31	40·0	19 1·72	33·58	28·14
32	50·0	11·75	43·62	28·13
33	56 1·0	22·78	53·67	[29·11†]
34	10·0	31·81	15 3·72	28·09
35	20·0	41·83	13·67	28·16
36	30·0	51·86	23·72	28·14
37	40·0	20 1·89	33·77	28·12
38	50·0	11·92	43·87	28·05
39	57 1·0	22·94	53·87	[29·07†]
40	10·0	31·97	16 3·91	28·06
41	20·0	42·00	13·86	28·14
42	30·0	52·02	23·91	28·11
43	40·0	21 2·05	33·91	28·14
44	50·0	12·08	43·91	28·17
45	58 1·0	23·11	53·96	[29·15†]
46	10·0	32·13	17 4·01	28·12
47	20·0	42·16	14·01	28·15
48	50·0	22 12·24	44·10	28·14
49	59 1·0	23·27	54·10	[29·17†]
50	10·0	32·30	18 4·20	28·10
51	20·0	42·33	14·10	28·23
52	30·0	52·35	24·10	28·25
53	40·0	23 2·38	34·30	28·08
54	14 59 50·0	11 23 12·41	11 18 44·39	28·02

* Signals at Berlin observed on the Morse tracer.

[†] Discordant; rejected.

1875, MARCH 10 (*continued*)

SET 2

Number of signal	Time by chronometer Nieberg	Malta sidereal time ; signals *received*	Corresponding Berlin sidereal time ; signals *sent*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	15 4 13·3	11 27 36·44	11 23 7·96	0 4 28·48
2	23·2	46·37	17·96	28·41
3	33·2	56·39	27·96	28·43
4	43·2	28 6·42	37·96	28·46
5	5 4·1	27·38	58·95	28·43
6	23·2	46·53	24 17·95	28·58
7	33·1	56·46	27·95	28·51
8	43·2	29 6·59	37·95	28·64
9	53·1	16·51	47·95	28·56
10	6 3·1	26·54	57·95	28·59
11	13·0	36·47	25 7·95	28·52
12	23·1	46·59	17·94	28·65
13	33·0	56·52	27·94	28·58
14	43·0	30 6·55	37·94	28·61
15	53·0	16·58	47·94	28·64
16	7 3·0	26·60	57·94	28·66
17	13·0	36·63	26 7·94	28·69
18	23·0	46·66	17·94	28·72
19	33·0	56·69	27·94	28·75
20	42·9	31 6·61	37·93	28·68
21	52·9	16·64	47·93	28·71
22	8 2·8	26·57	57·93	28·64
23	22·7	46·52	27 17·93	28·59
24	32·6	56·45	27·93	28·52
25	42·7	32 6·58	37·93	28·65
26	52·6	16·50	47·93	28·57
27	9 2·5	26·43	57·92	28·51
28	12·4	36·36	28 7·92	28·44
29	22·4	46·39	17·92	28·47
30	32·5	56·51	27·92	28·59
31	42·5	33 6·54	37·92	28·62
32	52·4	16·47	47·92	28·55
33	10 3·5	27·60	57·92	28·68
34	12·4	36·52	29 7·92	28·60
35	22·5	46·65	17·91	28·74
36	32·4	56·58	27·91	28·67
37	42·5	34 6·71	37·91	28·80
38	52·5	16·73	47·91	28·82
39	11 2·3	26·56	57·91	28·65
40	12·2	36·49	30 7·91	28·58
41	22·2	46·51	17·91	28·60
42	32·1	56·44	27·91	28·53
43	42·1	35 6·47	37·90	28·57
44	52·1	16·50	47·90	28·60
45	12 2·0	26·42	57·90	28·52
46	11·9	36·35	31 7·90	28·45
47	22·0	46·48	17·90	28·58
48	42·0	36 6·54	37·90	28·64
49	52·0	16·57	47·89	28·68
50	13 3·0	27·60	57·89	28·71
51	12·0	36·62	32 7·89	28·73
52	22·0	46·65	17·89	28·76
53	31·9	56·58	27·89	28·69
54	41·9	37 6·61	37·89	28·72
55	51·8	16·53	47·89	28·64
56	15 14 1·8	11 37 26·56	11 32 57·89	28·67

1875, MARCH 10 (*continued*)

SET 3

Number of signal	Time by chronometer Nieberg	Malta sidereal time ; signals *received*	Corresponding Berlin sidereal time ; signals *sent*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	17 44 36·0	14 8 25·65	14 3 56·88	0 4 28·77
2	46·0	35·67	4 6·87	28·80
3	55·9	45·60	16·87	28·73
4	45 5·8	55·53	26·87	28·66
5	25·6	9 15·38	46·87	28·51
6	45·6	35·44	5 6·86	28·58
7	55·7	45·56	16·86	28·70
8	46 5·7	55·59	26·86	28·73
9	15·5	10 5·42	36·86	28·56
10	25·6	15·55	46·85	28·70
11	47 5·5	55·55	6 26·84	28·71
12	15·5	11 5·58	36·84	28·74
13	25·5	15·61	46·84	28·77
14	45·4	35·56	7 6·84	28·72
15	55·3	45·49	16·83	28·66
16	48 5·4	55·62	26·83	28·79
17	15·3	12 5·55	36·83	28·72
18	25·2	15·47	46·83	28·64
19	35·2	25·50	56·83	28·67
20	45·1	35·43	8 6·82	28·61
21	55·2	45·56	16·82	28·74
22	49 5·1	55·48	26·82	28·66
23	15·1	13 5·51	36·82	28·69
24	25·0	15·44	46·81	28·63
25	35·0	25·46	56·81	28·65
26	45·0	35·49	9 6·81	28·68
27	55·0	45·52	16·81	28·71
28	50 5·0	55·55	26·81	28·74
29	15·0	14 5·57	36·80	28·77
30	24·9	15·50	46·80	28·70
31	44·8	35·46	10 6·80	28·66
32	54·8	45·48	16·80	28·68
33	51 4·7	55·41	26·79	28·62
34	14·7	15 5·44	36·79	28·65
35	24·7	15·46	46·79	28·67
36	34·6	25·39	56·79	28·60
37	44·6	35·42	11 6·78	28·64
38	55·6	46·45	16·78	[29·67*]
39	52 4·5	55·37	26·78	28·59
40	14·5	16 5·40	36·78	28·62
41	24·5	15·43	46·78	28·65
42	35·5	26·46	57·77	28·69
43	44·5	35·48	12 6·77	28·71
44	54·5	45·51	16·77	28·74
45	53 4·4	55·44	26·77	28·67
46	14·3	17 5·38	36·77	28·61
47	24·3	15·40	46·76	28·64
48	34·3	25·43	56·76	28·67
49	44·2	35·36	13 6·76	28·60
50	54·2	45·38	16·76	28·62
51	54 4·1	55·31	26·75	28·56
52	14·1	18 5·34	36·75	28·59
53	24·2	15·47	46·75	28·72
54	17 54 34·2	14 18 25·49	14 13 56·75	28·74

[*] Discordant ; rejected.

1875, MARCH 10 (*continued*)

SET 4: Morse

Number of signal	Time by chronometer Nieberg			Malta sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Malta east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	17	59	10·0	14	23	2·05	14	18	33·99	0	4	28·06
2			20·0			12·08			43·89			28·19
3			30·0			22·10			53·89			28·21
4			40·0			32·13		19	3·99			28·14
5			50·0			42·16			13·98			28·18
6	18	0	1·0			53·19			25·13			28·06
7			10·0		24	2·21			34·18			28·03
8			20·0			12·24			44·18			28·06
9			30·0			22·27			54·18			28·09
10			40·0			32·29		20	4·22			28·07
11			50·0			42·32			14·22			28·10
12		1	0·0			52·35			24·27			28·08
13			10·0		25	2·38			34·27			28·11
14			20·0			12·40			44·32			28·08
15			30·0			22·43			54·36			28·07
16			40·0			32·46		21	4·31			28·15
17			50·0			42·49			14·26			28·23
18		2	0·0			52·51			24·36			28·15
19			10·0		26	2·54			34·41			28·13
20			20·0			12·57			44·40			28·17
21			30·0			22·60			54·40			28·20
22			40·0			32·62		22	4·45			28·17
23			50·0			42·65			14·45			28·20
24		3	0·0			52·68			24·50			28·18
25			10·0		27	2·70			34·49			28·21
26			20·0			12·73			44·54			28·19
27			30·0			22·76			54·64			28·12
28			40·0			32·79		23	4·64			28·15
29			50·0			42·81			14·64			28·17
30		4	0·0			52·84			24·68			28·16
31			10·0		28	2·88			34·73			28·15
32			20·0			12·91			44·73			28·18
33			30·0			22·93			54·68			28·25
34			50·0			42·99		24	14·78			28·21
35		5	0·0			53·02			24·82			28·20
36			10·0		29	3·04			34·92			28·12
37			20·0			13·07			45·07			28·00
38			30·0			23·10			55·02			28·08
39			40·0			33·13		25	5·02			28·11
40			50·0			43·15			14·91			28·24
41		6	1·0			54·18			26·11			28·07
42			10·0		30	3·21			35·06			28·15
43			20·0			13·24			45·06			28·18
44			30·0			23·26			55·11			28·15
45			40·0			33·29		26	5·00			28·29
46			50·0			43·32			15·10			28·22
47		7	0·0			53·35			25·20			28·15
48			10·0		31	3·37			35·20			28·17
49			20·0			13·40			45·30			28·10
50			30·0			23·43			55·19			28·24
51			40·0			33·45		27	5·29			28·16
52			50·0			43·48			15·29			28·19
53		8	0·0			53·51			25·34			28·17
54			10·0		32	3·54			35·34			28·20
55			20·0			13·56			45·38			28·18
56			30·0			23·59			55·38			28·21
57			40·0			33·62		28	5·38			28·24
58			50·0			43·65			15·53			28·12
59		9	0·0			53·67			25·58			28·09
60	18	9	10·0	14	33	3·70	14	28	35·57			28·13

1875, MARCH 11

SET 5 : Morse

Number of signal	Time by chronometer Nieberg	Malta sidereal time ; signals *sent*	Corresponding Berlin sidereal time ; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 12 20·0	10 39 31·71	10 35 3·73	0 4 27·98
2	30·0	41·73	13·63	28·10
3	40·0	51·76	23·63	28·13
4	50·0	40 1·79	33·63	28·16
5	13 1·0	12·82	44·73	28·09
6	10·0	21·84	53·83	28·01
7	20·0	31·87	36 3·73	28·14
8	30·0	41·90	13·83	28·07
9	40·0	51·93	23·93	28·00
10	50·0	41 1·95	33·92	28·03
11	14 0·0	11·98	43·82	28·16
12	10·0	22·01	53·92	28·09
13	20·0	32·04	37 3·92	28·12
14	30·0	42·06	13·92	28·14
15	40·0	52·09	23·92	28·17
16	50·0	42 2·12	34·02	28·10
17	15 0·0	12·15	44·07	28·08
18	10·0	22·17	54·02	28·15
19	20·0	32·20	38 4·12	28·08
20	30·0	42·23	14·22	28·01
21	40·0	52·25	24·12	28·13
22	50·0	43 2·28	34·17	28·11
23	16 20·0	32·36	39 4·32	28·04
24	30·0	42·39	14·32	28·07
25	40·0	52·42	24·32	28·10
26	50·0	44 2·45	34·32	28·13
27	17 1·0	13·48	45·42	28·06
28	10·0	22·50	54·42	28·08
29	20·0	32·53	40 4·42	28·11
30	30·0	42·56	14·42	28·14
31	40·0	52·58	24·42	28·16
32	50·0	45 2·61	34·52	28·09
33	18 0·0	12·64	44·62	28·02
34	10·0	22·67	54·57	28·10
35	20·0	32·69	41 4·62	28·07
36	30·0	42·72	14·67	28·05
37	50·0	46 2·78	34·67	28·11
38	19 0·0	12·80	44·72	28·08
39	10·0	22·83	54·77	28·06
40	20·0	32·86	42 4·77	28·09
41	30·0	42·88	14·82	28·06
42	40·0	52·91	24·81	28·10
43	50·0	47 2·94	34·81	28·13
44	20 0·0	12·97	44·91	28·06
45	20·0	33·02	43 4·91	28·11
46	30·0	43·05	14·91	28·14
47	40·0	53·08	24·96	28·12
48	50·0	48 3·10	34·91	28·19
49	21 1·0	14·13	46·11	28·02
50	10·0	23·16	54·96	28·20
51	20·0	33·19	44 5·06	28·13
52	30·0	43·21	15·11	28·10
53	40·0	53·24	25·11	28·13
54	14 22 1·0	10 49 14·30	10 44 45·26	[29·04*]

[*] Discordant ; rejected.

1875, MARCH 11 (*continued*)

SET 6

Number of signal	Time by chronometer Nieberg	Malta sidereal time ; signals *received*	Corresponding Berlin sidereal time ; signals *sent*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 24 6·8	10 51 20·45	10 46 51·91	0 4 28·54
2	16·8	30·48	47 1·91	28·57
3	26·7	40·41	11·91	28·50
4	36·6	50·33	21·91	28·42
5	46·6	52 0·36	31·91	28·45
6	56·6	10·39	41·91	28·48
7	25 6·6	20·42	51·91	28·51
8	16·5	30·34	48 1·91	28·43
9	36·5	50·40	21·91	28·49
10	46·5	53 0·43	31·91	28·52
11	57·5	11·46	42·91	28·55
12	26 16·5	30·51	49 1·91	28·60
13	26·5	40·53	11·91	28·62
14	36·5	50·56	21·91	28·65
15	46·4	54 0·49	31·91	28·58
16	56·4	10·52	41·91	28·61
17	27 6·4	20·54	51·91	28·63
18	16·3	30·47	50 1·91	28·56
19	26·3	40·50	11·91	28·59
20	36·2	50·43	21·91	28·52
21	46·1	55 0·35	31·91	28·44
22	56·1	10·38	41·91	28·47
23	28 6·1	20·41	51·91	28·50
24	16·1	30·44	51 1·91	28·53
25	26·0	40·36	11·91	28·45
26	36·0	50·39	21·91	28·48
27	46·0	56 0·42	31·90	28·52
28	57·0	11·45	42·90	28·55
29	29 6·0	20·47	51·90	28·57
30	15·9	30·40	52 1·90	28·50
31	25·9	40·43	11·90	28·53
32	36·0	50·55	21·90	28·65
33	45·8	57 0·38	31·90	28·48
34	55·8	10·41	41·90	28·51
35	30 25·7	40·39	53 11·90	28·49
36	35·6	50·32	21·90	28·42
37	45·6	58 0·34	31·90	28·44
38	55·5	10·27	41·90	28·37
39	31 5·5	20·30	51·90	28·40
40	15·5	30·33	54 1·90	28·43
41	25·5	40·35	11·90	28·45
42	35·5	50·38	21·90	28·48
43	45·4	59 0·31	31·90	28·41
44	56·4	11·34	42·90	28·44
45	32 15·4	30·39	55 1·90	28·49
46	25·3	40·32	11·90	28·42
47	45·3	11 0 0·37	31·90	28·47
48	55·2	10·30	41·90	28·40
49	33 5·2	20·33	51·90	28·43
50	15·2	30·35	56 1·90	28·45
51	25·2	40·38	11·90	28·48
52	35·1	50·31	21·90	28·41
53	45·1	1 0·34	31·90	28·44
54	14 33 55·1	11 1 10·36	10 56 41·90	28·46

1875, MARCH 12

SET 7

Number of signal	Time by chronometer Nieberg			Malta sidereal time ; signals *received*			Corresponding Berlin sidereal time ; signals *sent*			Resulting longitude, Malta east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	14	18	17·4	10	49	27·28	10	44	58·48	0	4	28·80
2			27·4			37·30		45	8·48			28·82
3			37·3			47·23			18·48			28·75
4			47·2			57·16			28·47			28·69
5			57·2		50	7·19			38·47			28·72
6		19	7·2			17·21			48·47			28·74
7			17·1			27·14			58·47			28·67
8			27·2			37·27		46	8·47			28·80
9			37·1			47·20			18·47			28·73
10			48·1			58·23			29·47			28·76
11			57·0		51	7·15			38·47			28·68
12		20	7·0			17·18			48·47			28·71
13			17·0			27·21			58·47			28·74
14			27·0			37·23		47	8·47			28·76
15			36·9			47·16			18·47			28·69
16			46·9			57·19			28·47			28·72
17		21	6·7		52	17·04			48·47			28·57
18			16·7			27·07			58·47			28·60
19			26·6			37·00		48	8·47			28·53
20			36·7			47·12			18·46			28·66
21			46·7			57·15			28·46			28·69
22			56·7		53	7·18			38·46			28·72
23		22	7·7			18·21			48·46			[29·75*]
24			16·6			27·13			58·46			28·67
25			36·6			47·19		49	18·46			28·73
26			46·5			57·12			28·46			28·66
27			56·5		54	7·14			38·46			28·68
28		23	6·5			17·17			48·46			28·71
29			26·5			37·22		50	8·46			28·76
30			36·4			47·15			18·46			28·69
31			46·3			57·08			28·46			28·62
32			55·3		55	6·10			37·46			28·64
33		24	6·2			17·03			48·46			28·57
34			16·2			27·06			58·46			28·60
35			26·2			37·09		51	8·46			28·63
36			36·1			47·02			18·45			28·57
37			46·2			57·14			28·45			28·69
38			56·1		56	7·07			38·45			28·62
39		25	6·1			17·10			48·45			28·65
40			16·1			27·13			58·45			28·68
41			26·1			37·15		52	8·45			28·70
42			36·0			47·08			18·45			28·63
43			46·0			57·11			28·45			28·66
44			56·0		57	7·14			38·45			28·69
45		26	6·0			17·16			48·45			28·71
46			16·0			27·19			58·45			28·74
47			26·0			37·22		53	8·45			28·77
48			35·9			47·14			18·45			28·69
49			46·9			58·17			29·45			28·72
50		27	5·8		58	17·13			48·45			28·68
51			15·7			27·05			58·45			28·60
52			25·7			37·08		54	8·45			28·63
53			45·6			57·03			28·44			28·59
54			55·6		59	7·06			38·44			28·62
55		28	5·5			16·99			48·44			28·55
56	14	28	15·5	10	59	27·02	10	54	58·44			28·58

[*] Discordant ; rejected.

1875, MARCH 12 (*continued*)

SET 8 : Morse

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 34 0·0	11 5 12·46	11 0 44·42	0 4 28·04
2	10·0	22·50	54·32	28·18
3	20·0	32·52	1 4·32	28·20
4	30·0	42·55	14·36	28·19
5	40·0	52·58	24·41	28·17
6	50·0	6 2·60	34·46	28·14
7	35 1·0	13·63	45·51	28·12
8	10·0	22·66	54·51	28·15
9	20·0	32·69	2 4·56	28·13
10	39 40·0	10 53·40	6 25·24	28·16
11	50·0	11 3·43	35·29	28·14
12	40 0·0	13·45	45·34	28·11
13	10·0	23·48	55·34	28·14
14	20·0	33·51	7 5·39	28·12
15	30·0	43·54	15·39	28·15
16	40·0	53·56	25·39	28·17
17	50·0	12 3·59	35·49	28·10
18	41 1·0	14·62	46·53	28·09
19	10·0	23·65	55·48	28·17
20	20·0	33·67	8 5·43	28·24
21	30·0	43·70	15·58	28·12
22	40·0	53·73	25·53	28·20
23	43 0·0	14 13·95	9 45·78	28·17
24	10·0	23·97	55·83	28·14
25	20·0	34·00	10 5·87	28·13
26	30·0	44·03	15·87	28·16
27	40·0	54·06	25·92	28·14
28	50·0	15 4·08	35·97	28·11
29	44 0·0	14·11	46·02	28·09
30	51 50·0	23 5·41	18 37·29	28·12
31	52 0·0	15·43	47·33	28·10
32	10·0	25·46	57·28	28·18
33	20·0	35·49	19 7·33	28·16
34	30·0	45·52	17·38	28·14
35	40·0	55·54	27·38	28·16
36	14 52 50·0	11 24 5·57	11 19 37·43	28·14

1875, MARCH 12 (*continued*)

SET 9 : Relay

Number of signal	Time by chronometer Nieberg	Malta sidereal time ; signals *sent*	Corresponding Berlin sidereal time ; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 36 30·0	11 7 42·88	11 3 14·71	0 4 28·17
2	40·0	52·91	24·65	28·26
3	50·0	8 2·93	34·70	28·23
4	37 10·0	22·99	54·80	28·19
5	20·0	33·01	4 4·85	28·16
6	30·0	43·04	14·90	28·14
7	40·0	53·07	24·90	28·17
8	50·0	9 3·10	34·90	28·20
9	38 0·0	13·12	44·90	28·22
10	10·0	23·15	54·90	28·25
11	20·0	33·18	5 4·95	28·23
12	30·0	43·21	15·10	28·11
13	40·0	53·23	25·10	28·13
14	50·0	10 3·26	35·19	28·07
15	46 10·0	17 24·47	12 56·26	28·21
16	20·0	34·49	13 6·21	28·28
17	30·0	44·52	16·36	28·16
18	40·0	54·55	26·31	28·24
19	50·0	18 4·58	36·31	28·27
20	47 0·0	14·60	46·41	28·19
21	10·0	24·63	56·46	28·17
22	30·0	44·68	14 16·56	28·12
23	49 0·0	20 14·93	15 46·85	28·08
24	10·0	24·96	56·85	28·11
25	20·0	34·99	16 6·85	28·14
26	30·0	45·01	16·85	28·16
27	40·0	55·04	26·85	28·19
28	50·0	21 5·07	36·94	28·13
29	50 0·0	15·10	46·94	28·16
30	10·0	25·12	56·99	28·13
31	53 20·0	24 35·65	20 7·53	28·12
32	30·0	45·68	17·53	28·15
33	40·0	55·71	27·58	28·13
34	50·0	25 5·74	37·58	28·16
35	14 54 0·0	11 25 15·76	11 20 47·63	28·13

1875, MARCH 12 (*continued*)

SET 10: Relay

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	17 23 20·0	13 55 0·38	13 50 32·02	0 4 28·36
2	30·0	10·40	42·12	28·28
3	50·0	30·46	51 2·21	28·25
4	24 0·0	40·48	12·21	28·27
5	20·0	56 0·54	32·31	28·23
6	25 1·0	41·65	52 13·35	28·30
7	10·0	50·68	22·30	28·38
8	20·0	57 0·70	32·35	28·35
9	30·0	10·73	42·30	28·43
10	40·0	20·76	52·45	28·31
11	50·0	30·79	53 2·40	28·39
12	26 0·0	40·81	12·45	28·36
13	10·0	50·84	22·49	28·35
14	20·0	58 0·87	32·59	28·28
15	30·0	10·90	42·54	28·36
16	40·0	20·92	52·59	28·33
17	50·0	30·95	54 2·59	28·36
18	27 0·0	40·98	12·59	28·39
19	10·0	51·01	22·69	28·32
20	34 0·0	14 5 42·14	14 1 13·83	28·31
21	10·0	52·16	23·88	28·28
22	20·0	6 2·19	33·83	28·36
23	30·0	12·22	43·93	28·29
24	40·0	22·25	53·93	28·32
25	50·0	32·27	2 3·92	28·35
26	35 0·0	42·30	13·97	28·33
27	10·0	52·33	24·02	28·31
28	20·0	7 2·36	34·02	28·34
29	37 10·0	8 52·66	4 24·25	28·41
30	20·0	9 2·69	34·40	28·29
31	30·0	12·71	44·35	28·36
32	40·0	22·74	54·40	28·34
33	50·0	32·77	5 4·50	28·27
34	38 0·0	42·79	14·50	28·29
35	10·0	52·82	24·50	28·32
36	17 38 20·0	14 10 2·85	14 5 34·59	28·26

SET 11: Morse

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s
1	17 27 50·0	13 59 31·11	13 55 2·88	0 4 28·23
2	28 0·0	41·14	12·93	28·21
3	10·0	51·17	22·88	28·29
4	20·0	14 0 1·20	32·93	28·27
5	17 28 30·0	14 0 11·22	13 55 42·93	28·29

1875, MARCH 12 (*continued*)

SET 11: Morse (*continued*)

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
6	17 28 40·0	14 0 21·25	13 55 52·97	0 4 28·28
7	50·0	31·28	56 3·07	28·21
8	29 1·0	42·31	14·02	28·29
9	10·0	51·33	23·02	28·31
10	20·0	1 1·36	33·12	28·24
11	30·0	11·40	43·12	28·28
12	40·0	21·43	53·12	28·31
13	31 0·0	2 41·64	58 13·36	28·28
14	10·0	51·67	23·35	28·32
15	20·0	3 1·70	33·40	28·30
16	30·0	11·73	43·45	28·28
17	40·0	21·75	53·45	28·30
18	50·0	31·78	59 3·55	28·23
19	32 10·0	51·84	23·55	28·29
20	20·0	4 1·86	33·59	28·27
21	39 40·0	11 23·07	14 6 54·78	28·29
22	50·0	33·10	7 4·78	28·32
23	40 0·0	43·12	14·93	28·19
24	10·0	53·15	24·88	28·27
25	20·0	12 3·18	34·83	28·35
26	30·0	13·20	44·88	28·32
27	40·0	23·23	54·93	28·30
28	50·0	33·26	8 4·92	28·34
29	41 0·0	43·29	15·02	28·27
30	10·0	53·31	24·97	28·34
31	42 40·0	14 23·56	9 55·21	28·35
32	50·0	33·59	10 5·31	28·28
33	43 1·0	44·62	16·36	28·26
34	10·0	53·64	25·36	28·28
35	17 43 20·0	14 15 3·67	14 10 35·40	28·27

SET 12

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *received*	Corresponding Berlin sidereal time; signals *sent*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	17 45 12·1	14 16 56·08	14 12 27·34	0 4 28·74
2	22·0	17 6·00	37·33	28·67
3	32·1	16·13	47·33	28·80
4	42·0	26·06	57·33	28·73
5	52·0	36·09	13 7·33	28·76
6	46 2·0	46·11	17·33	28·78
7	13·0	57·14	28·33	28·81
8	21·9	18 6·07	37·32	28·75
9	31·8	16·00	47·32	28·68
10	41·8	26·02	57·32	28·70
11	51·9	36·15	14 7·32	28·83
12	17 47 1·7	14 18 45·98	14 14 17·32	28·66

1875, MARCH 12 (*continued*)

SET 12 (*continued*)

Number of signal	Time by chronometer Nieberg	Malta sidereal time ; signals *received*	Corresponding Berlin sidereal time ; signals *sent*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
13	17 47 21·6	14 19 5·94	14 14 37·31	0 4 28·63
14	31·7	16·07	47·31	28·76
15	41·6	26·00	57·31	28·69
16	51·6	36·02	15 7·31	28·71
17	48 11·5	55·98	27·31	28·67
18	31·5	20 16·03	47·30	28·73
19	41·5	26·06	57·30	28·76
20	51·5	36·09	16 7·30	28·79
21	49 1·4	46·02	17·30	28·72
22	11·5	56·14	27·30	28·84
23	21·3	21 5·97	37·30	28·67
24	31·2	15·90	47·29	28·61
25	41·3	26·03	57·29	28·74
26	51·2	35·95	17 7·29	28·66
27	50 1·1	45·88	17·29	28·59
28	21·1	22 5·93	37·29	28·64
29	31·2	16·06	47·28	28·78
30	41·1	25·99	57·28	28·71
31	51·1	36·02	18 7·28	28·74
32	51 1·0	45·94	17·28	28·66
33	10·9	55·87	27·28	28·59
34	21·0	23 6·00	37·28	28·72
35	31·0	16·03	47·27	28·76
36	41·0	26·05	57·27	28·78
37	51·0	36·08	19 7·27	28·81
38	52 0·9	46·01	17·27	28·74
39	10·9	56·03	27·27	28·76
40	20·8	24 5·96	37·27	28·69
41	30·7	15·89	47·26	28·63
42	40·7	25·92	57·26	28·66
43	50·7	35·94	20 7·26	28·68
44	53 0·6	45·87	17·26	28·61
45	10·6	55·90	27·26	28·64
46	20·6	25 5·93	37·26	28·67
47	30·5	15·85	47·25	28·60
48	41·5	26·88	57·25	[29·63*]
49	50·5	35·91	21 7·25	28·66
50	54 0·5	45·94	17·25	28·69
51	11·4	56·86	28·25	28·61
52	20·4	26 5·89	37·25	28·64
53	30·4	15·92	47·24	28·68
54	40·3	25·84	57·24	28·60
55	50·3	35·87	22 7·24	28·63
56	55 0·2	45·80	17·24	28·56
57	17 55 10·2	14 26 55·83	14 22 27·24	28·59

[*] Discordant ; rejected.

1875, MARCH 14

SET 13: Relay

Number of signal	Time by chronometer Nieberg			Malta sidereal time; signals *received*			Corresponding Berlin sidereal time; signals *sent*			Resulting longitude, Malta east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	13	58	43·2	10	37	43·41	10	33	14·96	0	4	28·45
2			53·2			53·44			24·96			28·48
3		59	3·1		38	3·37			34·96			28·41
4			13·1			13·39			44·96			28·43
5			23·1			23·42			54·96			28·46
6			33·1			33·45		34	4·96			28·49
7			43·0			43·38			14·97			28·41
8			53·1			53·50			24·97			28·53
9	14	0	3·0		39	3·44			34·97			28·47
10			14·0			14·47			45·97			28·50
11			33·0			33·52		35	4·97			28·55
12			43·0			43·55			14·97			28·58
13			52·9			53·48			24·98			28·50
14		1	2·9		40	3·51			34·98			28·53
15			12·8			13·43			44·98			28·45
16			22·8			23·46			54·98			28·48
17			32·8			33·49		36	4·98			28·51
18			42·8			43·51			14·98			28·53
19			52·7			53·44			24·98			28·46
20		2	2·7		41	3·47			34·98			28·49
21			22·7			23·52			54·99			28·53
22			42·6			43·48		37	14·99			28·49
23			52·5			53·41			24·99			28·42
24		3	2·5		42	3·43			34·99			28·44
25			13·5			14·46			45·99			28·47
26			22·5			23·49			55·00			28·49
27			32·5			33·52		38	5·00			28·52
28			42·5			43·54			15·00			28·54
29			52·4			53·47			25·00			28·47
30		4	2·4		43	3·50			35·00			28·50
31			12·3			13·42			45·00			28·42
32			22·4			23·55			55·00			28·55
33			32·3			33·48		39	5·00			28·48
34			42·3			43·51			15·01			28·50
35			52·3			53·53			25·01			28·52
36		5	2·3		44	3·56			35·01			28·55
37			12·2			13·49			45·01			28·48
38			22·2			23·52			55·01			28·51
39			32·2			33·54		40	5·01			28·53
40			52·1			53·50			25·01			28·49
41		6	2·2		45	3·63			35·02			28·61
42			12·1			13·55			45·02			28·53
43			22·1			23·58			55·02			28·56
44			32·0			33·51		41	5·02			28·49
45			42·0			43·53			15·02			28·51
46			52·0			53·56			25·02			28·54
47		7	2·0		46	3·59			35·02			28·57
48			12·9			14·52			46·03			28·49
49			21·9			23·54			55·03			28·51
50			31·8			33·47		42	5·03			28·44
51			41·9			43·60			15·03			28·57
52			51·8			53·52			25·03			28·49
53		8	1·7		47	3·45			35·03			28·42
54			11·7			13·48			45·03			28·45
55			21·7			23·51			55·04			28·47
56			31·7			33·53		43	5·04			28·49
57	14	8	41·7	10	47	43·56	10	43	15·04			28·52

1875, MARCH 14 (*continued*)

SET 14 : Morse

Number of signal	Time by chronometer Nieberg	Malta sidereal time ; signals *sent*	Corresponding Berlin sidereal time ; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 15 30·0	10 54 32·99	10 50 4·99	0 4 28·00
2	40·0	43·02	14·89	28·13
3	50·0	53·04	25·04	28·00
4	16 1·0	55 4·07	36·09	27·98
5	10·0	13·10	46·15	[26·95*]
6	20·0	23·13	55·10	28·03
7	30·0	33·15	51 5·15	28·00
8	40·0	43·18	15·15	28·03
9	50·0	53·21	25·20	28·01
10	17 0·0	56 3·24	35·25	27·99
11	25 30·0	11 4 34·63	11 0 6·57	28·06
12	50·0	54·69	26·67	28·02
13	26 0·0	5 4·72	36·72	28·00
14	10·0	14·75	46·67	28·08
15	20·0	24·78	56·67	28·11
16	30·0	34·81	1 6·73	28·08
17	40·0	44·83	16·88	27·95
18	50·0	54·86	26·78	28·08
19	27 0·0	6 4·89	36·83	28·06
20	28 40·0	7 45·16	3 17·04	28·12
21	50·0	55·19	27·14	28·05
22	29 1·0	8 6·22	38·20	28·02
23	20·0	25·27	57·20	28·07
24	30·0	35·30	4 7·25	28·05
25	40·0	45·33	17·30	28·03
26	50·0	55·35	27·25	28·10
27	30 0·0	9 5·38	37·30	28·08
28	34 40·0	13 46·15	9 18·14	28·01
29	50·0	56·18	28·14	28·04
30	35 1·0	14 7·20	39·14	28·06
31	10·0	16·23	48·19	28·04
32	20·0	26·26	58·19	28·07
33	14 35 30·0	11 14 36·28	11 10 8·25	28·03

[*] Discordant ; rejected.

1875, MARCH 14 (*continued*)

SET 15: Relay

Number of signal	Time by chronometer Nieberg			Malta sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Malta east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	14	19	0·0	10	58	3·56	10	53	35·52	0	4	28·04
2			10·0			13·59			45·57			28·02
3			20·0			23·62			55·52			28·10
4			30·0			33·65		54	5·52			28·13
5			40·0			43·67			15·57			28·10
6			50·0			53·70			25·62			28·08
7		20	0·0		59	3·73			35·63			28·10
8			10·0			13·76			45·73			28·03
9			20·0			23·78			55·68			28·10
10			30·0			33·81		55	5·73			28·08
11			40·0			43·84			15·78			28·06
12		22	10·0	11	1	14·09		56	45·99			28·10
13			20·0			24·11			56·04			28·07
14			30·0			34·14		57	6·09			28·05
15			40·0			44·17			16·10			28·07
16			50·0			54·20			26·15			28·05
17		23	1·0		2	5·22			37·15			28·07
18			10·0			14·25			46·15			28·10
19			20·0			24·28			56·20			28·08
20			30·0			34·30		58	6·20			28·10
21			40·0			44·33			16·15			28·18
22			50·0			54·36			26·25			28·11
23		24	0·0		3	4·39			36·31			28·08
24		32	10·0		11	15·74	11	6	47·62			28·12
25			20·0			25·77			57·62			28·15
26			30·0			35·79		7	7·67			28·12
27			40·0			45·82			17·72			28·10
28			50·0			55·85			27·73			28·12
29		33	0·0		12	5·87			37·83			28·04
30			10·0			15·90			47·78			28·12
31			20·0			25·93			57·83			28·10
32	14	33	30·0	11	12	35·96	11	8	7·93			28·03

SET 16: Morse

Number of signal	Time by chronometer Nieberg			Malta sidereal time; signals *sent*			Corresponding Berlin sidereal time; signals *received*			Resulting longitude, Malta east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s	h.	m.	s.
1	16	34	30·0	13	13	55·93	13	9	27·81	0	4	28·12
2			40·0		14	5·96			37·81			28·15
3			50·0			15·99			47·86			28·13
4		35	0·0			26·02			57·86			28·16
5			20·0			46·07		10	17·91			28·16
6			30·0			56·10			28·01			28·09
7			40·0		15	6·13			37·92			28·21
8			50·0			16·15			48·02			28·13
9		43	20·0		22	47·39		18	19·25			28·14
10			30·0			57·41			29·15			28·26
11			40·0		23	7·44			39·25			28·19
12			50·0			17·47			49·90			28·17
13		44	0·0			27·49			59·35			28·14
14			10·0			37·52		19	9·31			28·21
15			20·0			47·55			19·36			28·19
16	16	44	30·0	13	23	57·58	13	19	29·36			28·22

1875, MARCH 14 (*continued*)

SET 16: Morse (*continued*)

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
17	16 44 40·0	13 24 7·60	13 19 39·41	0 4 28·19
18	50·0	17·63	49·46	28·17
19	45 0·0	27·66	59·46	28·20
20	10·0	37·69	20 9·46	28·23
21	46 50·0	26 17·96	21 49·77	28·19
22	47 0·0	27·99	59·82	28·17
23	10·0	38·01	22 9·82	28·19
24	20·0	48·05	19·82	28·23
25	30·0	58·08	29·87	28·21
26	40·0	27 8·11	39·87	28·24
27	50·0	18·13	49·87	28·26
28	48 0·0	28·16	59·97	28·19
29	10·0	38·19	23 9·92	28·27
30	20·0	48·22	19·97	28·25
31	30·0	58·24	30·03	28·21
32	40·0	28 8·27	40·08	28·19
33	49 1·0	29·33	24 1·18	28·15
34	54 10·0	33 39·18	29 10·90	28·28
35	20·0	49·20	21·00	28·20
36	16 54 30·0	13 33 59·23	13 29 31·10	28·13

SET 17: Relay

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	16 37 1·0	13 16 27·35	13 11 59·02	0 4 28·33
2	20·0	46·40	12 18·22	28·18
3	30·0	56·43	28·32	28·11
4	40·0	17 6·46	38·22	28·24
5	38 0·0	26·51	58·33	28·18
6	10·0	36·54	13 8·33	28·21
7	20·0	46·57	18·38	28·19
8	30·0	56·59	28·38	28·21
9	40·0	18 6·62	38·43	28·19
10	50·0	16·65	48·43	28·22
11	39 0·0	26·68	58·48	28·20
12	40 30·0	19 56·92	15 28·69	28·23
13	40·0	20 6·95	38·64	28·31
14	50·0	16·98	49·69	[27·29*]
15	41 0·0	27·01	58·74	28·27
16	10·0	37·03	16 8·84	28·19
17	20·0	47·06	18·84	28·22
18	30·0	57·09	28·94	28·15
19	40·0	21 7·11	38·89	28·22
20	50·0	17·14	48·94	28·20
21	42 0·0	27·17	59·00	28·17
22	50 10·0	29 38·52	25 10·28	28·24
23	20·0	48·55	20·38	28·17
24	50·0	30 18·63	50·39	28·24
25	51 0·0	28·66	26 0·59	28·07
26	20·0	48·71	20·54	28·17
27	30·0	58·74	30·49	28·25
28	16 51 40·0	13 31 8·77	13 26 40·49	28·28

[*] Discordant; rejected.

1875, MARCH 14 (*continued*)

SET 18

Number of signal	Time by chronometer Nieberg			Malta sidereal time ; signals *received*			Corresponding Berlin sidereal time ; signals *sent*			Resulting longitude, Malta east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	17	14	22·2	13	53	54·71	13	49	26·01	0	4	28·70
2			32·2		54	4·74			36·01			28·73
3			42·1			14·67			46·01			28·66
4			52·1			24·70			56·02			28·68
5		15	2·0			34·62		50	6·02			28·60
6			12·0			44·65			16·02			28·63
7			22·0			54·68			26·02			28·66
8			32·0		55	4·70			36·02			28·68
9			43·0			15·73			47·02			28·71
10			51·9			24·66			56·02			28·64
11		16	1·9			34·69		51	6·02			28·67
12			11·8			44·61			16·02			28·59
13			21·8			54·64			26·02			28·62
14			31·8		56	4·67			36·02			28·65
15			41·8			14·70			46·02			28·68
16			51·7			24·62			56·03			28·59
17		17	1·7			34·65		52	6·03			28·62
18			11·6			44·58			16·03			28·55
19			21·6			54·60			26·03			28·57
20			31·6		57	4·63			36·03			28·60
21			41·6			14·66			46·03			28·63
22			51·6			24·69			56·03			28·66
23		18	1·5			34·61		53	6·03			28·58
24			11·5			44·64			16·03			28·61
25			21·5			54·67			26·03			28·64
26			31·5		58	4·70			36·03			28·67
27			41·5			14·72			46·03			28·69
28			51·4			24·65			56·04			28·61
29		19	1·4			34·68		54	6·04			28·64
30			11·4			44·71			16·04			28·67
31			21·3			54·63			26·04			28·59
32			31·3		59	4·66			36·04			28·62
33			41·3			14·69			46·04			28·65
34			51·2			24·61			56·04			28·57
35		20	1·2			34·64		55	6·04			28·60
36			11·1			44·57			16·04			28·53
37			21·2			54·70			26·04			28·66
38			31·1	14	0	4·62			36·04			28·58
39			42·1			15·65			47·04			28·61
40			51·1			24·68			56·04			28·64
41		21	1·1			34·71		56	6·05			28·66
42			11·0			44·63			16·05			28·58
43			21·0			54·66			26·05			28·61
44			31·0		1	4·69			36·05			28·64
45			41·0			14·72			46·05			28·67
46			50·9			24·64			56·05			28·59
47		22	0·9			34·67		57	6·05			28·62
48			10·8			44·60			16·05			28·55
49			20·8			54·62			26·05			28·57
50			30·7		2	4·55			36·05			28·50
51			40·7			14·58			46·05			28·53
52			50·7			24·61			56·05			28·56
53		23	0·7			34·63		58	6·06			28·57
54			10·6			44·56			16·06			28·50
55			20·7			54·69			26·06			28·63
56			30·6		3	4·62			36·06			28·56
57			41·6			15·65			47·06			28·59
58			50·6			24·67			56·06			28·61
59		24	0·6			34·70		59	6·06			28·64
60			10·5			44·63			16·06			28·57
61	17	24	20·5	14	3	54·65	13	59	26·06			28·59

1875, MARCH 15

SET 19: Morse

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 0 0·0	10 42 57·52	10 38 29·05	0 4 28·47
2	10·0	43 7·55	39·25	28·30
3	20·0	17·58	49·30	28·28
4	30·0	27·61	59·34	28·27
5	40·0	37·63	39 9·24	28·39
6	50·0	47·66	19·29	28·37
7	1 1·0	58·69	30·44	28·25
8	20·0	44 17·74	49·34	28·40
9	30·0	27·77	59·39	28·38
10	40·0	37·80	40 9·33	28·47
11	50·0	47·83	19·48	28·35
12	2 0·0	57·85	29·53	28·32
13	10·0	45 7·88	39·53	28·35
14	20·0	17·91	49·58	28·33
15	30·0	27·94	59·57	28·37
16	40·0	37·96	41 9·62	28·34
17	14 2 50·0	10 45 47·99	10 41 19·62	28·37

SET 20: Relay

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 3 10·0	10 46 8·05	10 41 39·72	0 4 28·33
2	20·0	18·07	49·77	28·30
3	30·0	28·10	59·82	28·28
4	40·0	38·13	42 9·71	28·42
5	50·0	48·15	19·76	28·39
6	4 0·0	58·18	29·81	28·37
7	10·0	47 8·21	39·81	28·40
8	20·0	18·24	49·81	28·43
9	30·0	28·26	59·86	28·40
10	40·0	38·29	43 9·90	28·39
11	50·0	48·32	19·85	28·47
12	5 0·0	58·35	29·95	28·40
13	10·0	48 8·37	39·95	28·42
14	20·0	18·40	50·00	28·40
15	30·0	28·43	44 0·05	28·38
16	40·0	38·46	10·09	28·37
17	50·0	48·48	20·09	28·39
18	6 1·0	59·51	31·14	28·37
19	10·0	49 8·54	40·14	28·40
20	30·0	28·59	45 0·19	28·40
21	40·0	38·62	10·18	28·44
22	50·0	48·65	20·23	28·42
23	14 7 0·0	10 49 58·67	10 45 30·28	28·39

1875, MARCH 15 (*continued*)

SET 21

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *received*	Corresponding Berlin sidereal time; signals *sent*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 8 11·8	10 51 10·68	10 46 40·97	0 4 29·71*
2	21·8	20·71	50·97	29·74
3	31·7	30·64	47 0·97	29·67
4	41·7	40·66	10·97	29·69
5	9 0·6	59·62	30·97	28·65
6	10 20·5	53 19·74	48 50·96	28·78
7	30·4	29·66	49 0·96	28·70
8	40·5	39·79	10·96	28·83
9	50·5	49·82	20·96	28·86
10	11 0·4	59·75	30·96	28·79
11	10·3	54 9·67	40·96	28·71
12	20·2	19·60	50·96	28·64
13	30·2	29·63	50 0·95	28·68
14	40·2	39·65	10·95	28·70
15	50·1	49·58	20·95	28·63
16	12 0·1	59·61	30·95	28·66
17	10·0	55 9·54	40·95	28·59
18	20·1	19·66	50·95	28·71
19	30·2	29·79	51 0·95	28·84
20	40·0	39·62	10·95	28·67
21	50·0	49·65	20·95	28·70
22	13 0·0	59·67	30·95	28·72
23	10·0	56 9·70	40·95	28·75
24	20·0	19·73	50·94	28·79
25	29·9	29·66	52 0·94	28·72
26	39·9	39·68	10·94	28·74
27	49·8	49·61	20·94	28·67
28	59·8	59·64	30·94	28·70
29	14 10·7	57 10·57	41·94	28·63
30	19·7	19·59	50·94	28·65
31	29·7	29·62	53 0·94	28·68
32	39·6	39·54	10·94	28·60
33	49·6	49·57	20·94	28·63
34	59·6	59·60	30·93	28·67
35	14 15 9·6	10 58 9·63	10 53 40·93	28·70

SET 22: Morse

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 16 20·0	10 59 20·22	10 54 51·93	0 4 28·29
2	30·0	30·25	55 1·88	28·37
3	40·0	40·27	11·92	28·35
4	50·0	50·30	21·92	28·38
5	17 0·0	11 0 0·33	31·97	28·36
6	10·0	10·36	42·02	28·34
7	30·0	30·41	56 2·02	28·39
8	40·0	40·44	12·07	28·37
9	50·0	50·46	22·12	28·34
10	18 0·0	1 0·49	32·11	28·38
11	14 18 10·0	11 1 10·52	10 56 42·16	28·36

[*] Discordant; rejected.

1875, MARCH 15 (*continued*)

SET 23: Relay

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 18 40·0	11 1 40·60	10 57 12·21	0 4 28·39
2	50·0	50·63	22·21	28·42
3	19 0·0	2 0·66	32·21	28·45
4	10·0	10·68	42·31	28·37
5	20·0	20·71	52·30	28·41
6	30·0	30·74	58 2·40	28·34
7	40·0	40·77	12·40	28·37
8	50·0	50·79	22·40	28·39
9	20 0·0	3 0·82	32·45	28·37
10	10·0	10·85	42·45	28·40
11	20·0	20·87	52·50	28·37
12	30·0	30·91	59 2·49	28·42
13	40·0	40·94	12·54	28·40
14	50·0	50·97	22·49	28·48
15	21 0·0	4 0·99	32·59	28·40
16	10·0	11·02	42·64	28·38
17	20·0	21·05	52·64	28·41
18	30·0	31·08	11 0 2·69	28·39
19	40·0	41·10	12·74	28·36
20	50·0	51·13	22·74	28·39
21	22 1·0	5 2·16	33·78	28·38
22	10·0	11·19	42·83	28·36
23	20·0	21·21	52·83	28·38
24	30·0	31·24	1 2·88	28·36
25	40·0	41·27	12·88	28·39
26	50·0	51·30	22·88	28·42
27	23 0·0	6 1·32	32·93	28·39
28	14 23 10·0	11 6 11·35	11 1 42·98	28·37

SET 24

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *received*	Corresponding Berlin sidereal time; signals *sent*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 24 7·9	11 7 9·41	11 2 40·87	0 4 28·54
2	18·0	19·54	50·87	28·67
3	28·0	29·56	3 0·87	28·69
4	51·0	52·63	20·86	[31·77*]
5	58·0	59·65	30·86	28·79
6	25 9·0	8 10·68	41·86	28·82
7	18·0	19·70	50·86	28·84
8	27·8	29·53	4 0·86	28·67
9	37·7	39·46	10·86	28·60
10	47·7	49·48	20·86	28·62
11	27 27·4	10 29·46	6 0·84	28·62
12	37·4	39·48	10·84	28·64
13	47·5	49·61	20·84	28·77
14	30 37·0	13 39·58	9 10·82	28·76
15	47·0	49·60	20·82	28·78
16	57·0	59·63	30·82	28·81
17	14 31 7·0	11 14 9·66	11 9 40·82	28·84

[*] Discordant; rejected.

1875, MARCH 15 (*continued*)

SET 25

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *received*	Corresponding Berlin sidereal time; signals *sent*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 42 5·1	11 25 9·57	11 20 40·73	0 4 28·84
2	15·0	19·50	50·73	28·77
3	25·0	29·52	21 0·73	28·79
4	35·0	39·55	10·73	28·82
5	44·9	49·48	20·73	28·75
6	54·8	59·41	30·72	28·69
7	43 5·8	26 10·44	41·72	28·72
8	14·8	19·46	50·72	28·74
9	24·7	29·39	22 0·72	28·67
10	34·7	39·42	10·72	28·70
11	44·7	49·44	20·72	28·72
12	54·6	59·37	30·72	28·65
13	44 5·6	27 10·40	41·72	28·68
14	14·6	19·42	50·71	28·71
15	24·6	29·45	23 0·71	28·74
16	34·5	39·38	10·71	28·67
17	44·5	49·41	20·71	28·70
18	54·5	59·43	30·71	28·72
19	45 4·5	28 9·46	40·71	28·75
20	14·5	19·49	50·71	28·78
21	23·4	28·41	59·71	28·70
22	34·4	39·44	24 10·70	28·74
23	44·4	49·47	20·70	28·77
24	54·3	59·40	30·70	28·70
25	46 4·3	29 9·42	40·70	28·72
26	14·2	19·36	50·70	28·66
27	24·2	29·39	25 0·70	28·69
28	34·2	39·42	10·70	28·72
29	44·1	49·34	20·69	28·65
30	54·2	59·47	30·69	28·78
31	47 4·1	30 9·40	40·69	28·71
32	14·0	19·33	50·69	28·64
33	24·0	29·35	26 0·69	28·66
34	34·0	39·38	10·69	28·69
35	44·0	49·41	20·69	28·72
36	54·0	59·44	30·69	28·75
37	48 3·9	31 9·36	40·68	28·68
38	13·8	19·29	50·68	28·61
39	23·8	29·32	27 0·68	28·64
40	33·8	39·34	10·68	28·66
41	43·8	49·37	20·68	28·69
42	53·7	59·30	30·68	28·62
43	14 49 3·7	11 32 9·33	11 27 40·68	28·65

SET 26: Morse

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 50 0·0	11 33 5·78	11 28 37·17	0 4 28·61
2	10·0	15·81	47·37	28·44
3	20·0	25·83	57·57	28·26
4	30·0	35·86	29 7·52	28·34
5	40·0	45·89	17·56	28·33
6	50·0	55·92	27·56	28·36
7	51 1·0	34 6·95	38·66	28·29
8	10·0	15·97	47·66	28·31
9	20·0	26·00	57·66	28·34
10	30·0	36·03	30 7·66	28·37
11	40·0	46·05	17·66	28·39
12	50·0	56·08	27·66	28·42
13	52 0·0	35 6·11	37·70	28·41
14	10·0	16·13	47·80	28·33
15	20·0	26·16	57·80	28·36
16	30·0	36·19	31 7·85	28·34
17	40·0	46·22	17·90	28·32
18	14 52 50·0	11 35 56·24	11 31 27·90	28·34

1875, MARCH 15 (*continued*)

SET 27 : Relay

Number of signal	Time by chronometer Nieberg			Malta sidereal time ; signals *sent*			Corresponding Berlin sidereal time ; signals *received*			Resulting longitude, Malta east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	14	53	10·0	11	36	16·30	11	31	47·94	0	4	28·36
2			20·0			26·33			58·04			28·39
3			30·0			36·35		32	8·04			28·31
4			40·0			46·38			18·04			28·34
5			50·0			56·41			28·04			28·37
6		54	0·0		37	6·44			38·14			28·30
7			10·0			16·46			48·14			28·32
8			20·0			26·49			58·14			28·35
9			30·0			36·52		33	8·13			28·39
10			40·0			46·55			18·18			28·37
11			50·0			56·57			28·18			28·39
12		55	0·0		38	6·60			38·23			28·37
13			10·0			16·63			48·23			28·40
14			20·0			26·66			58·33			28·33
15			30·0			36·68		34	8·38			28·30
16			40·0			46·71			18·38			28·33
17			50·0			56·74			28·37			28·37
18		56	1·0		39	7·77			39·42			28·35
19			10·0			16·79			48·42			28·37
20			20·0			26·82			58·47			28·35
21			30·0			36·85		35	8·62			28·23
22			40·0			46·88			18·57			28·31
23			50·0			56·90			28·52			28·38
24	14	57	0·0	11	40	6·93	11	35	38·61			28·32

SET 28

Number of signal	Time by chronometer Nieberg			Malta sidereal time ; signals *received*			Corresponding Berlin sidereal time ; signals *sent*			Resulting longitude, Malta east of Berlin		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	15	1	1·7	11	44	9·30	11	39	40·60	0	4	28·70
2			11·7			19·33			50·60			28·73
3			21·6			29·25		40	0·60			28·65
4			31·7			39·38			10·60			28·78
5			41·6			49·31			20·60			28·71
6			51·6			59·34			30·60			28·74
7		2	1·6		45	9·36			40·60			28·76
8			11·5			19·29			50·60			28·69
9			21·5			29·32		41	0·60			28·72
10			31·5			39·35			10·59			28·76
11			41·5			49·37			20·59			28·78
12			51·5			59·40			30·59			28·81
13		3	2·5		46	10·43			41·59			28·84
14			11·4			19·36			50·59			28·77
15			21·3			29·28		42	0·59			28·69
16			31·4			39·41			10·59			28·82
17			41·3			49·34			20·59			28·75
18			51·2			59·26			30·59			28·67
19		4	1·2		47	9·29			40·59			28·70
20			11·3			19·42			50·59			28·83
21			21·2			29·35		43	0·59			28·76
22			31·1			39·27			10·59			28·68
23			41·1			49·30			20·59			28·71
24			51·1			59·33			30·59			28·74
25		5	1·0		48	9·26			40·59			28·67
26			11·1			19·38			50·59			28·79
27			21·0			29·31		44	0·59			28·72
28			31·0			39·34			10·59			28·75
29			41·0			49·36			20·59			28·77
30			51·0			59·39			30·59			28·80
31		6	0·9		49	9·32			40·59			28·73
32			10·8			19·25			50·59			28·66
33	15	6	20·8	11	49	29·27	11	45	0·59			28·68

1875, MARCH 15 (*continued*)

SET 28 (*continued*)

Number of signal	Time by chronometer Nieberg	Malta sidereal time ; signals *received*	Corresponding Berlin sidereal time ; signals *sent*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
34	15 6 30·8	11 49 39·30	11 45 10·59	0 4 28·71
35	40·8	49·33	20·59	28·74
36	50·7	59·26	30·59	28·67
37	7 1·7	50 10·29	41·59	28·70
38	10·7	19·31	50·59	28·72
39	20·7	29·34	46 0·59	28·75
40	30·6	39·26	10·59	28·67
41	40·6	49·29	20·59	28·70
42	50·5	59·22	30·59	28·63
43	15 8 0·5	11 51 9·25	11 46 40·59	28·66

SET 29 : Relay

Number of signal	Time by chronometer Nieberg	Malta sidereal time ; signals *sent*	Corresponding Berlin sidereal time ; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	15 9 0·0	11 52 8·91	11 47 40·54	0 4 28·37
2	20·0	28·96	48 0·69	28·27
3	30·0	38·99	10·73	28·26
4	40·0	49·02	20·73	28·29
5	10 0·0	53 9·07	40·83	28·24
6	10·0	19·10	50·88	28·22
7	20·0	29·13	49 0·83	28·30
8	30·0	39·16	10·83	28·33
9	40·0	49·18	20·88	28·30
10	50·0	59·21	30·88	28·33
11	11 0·0	54 9·24	40·93	28·31
12	10·0	19·27	51·08	28·19
13	20·0	29·29	50 0·88	28·41
14	30·0	39·32	10·98	28·34
15	40·0	49·35	21·03	28·32
16	50·0	59·39	31·08	28·31
17	12 0·0	55 9·41	41·08	28·33
18	10·0	19·44	51·13	28·31
19	20·0	29·47	51 1·08	28·39
20	30·0	39·50	11·13	28·37
21	40·0	49·52	21·18	28·34
22	50·0	59·55	31·18	28·37
23	13 0·0	56 9·58	41·33	28·25
24	15 13 10·0	11 56 19·60	11 51 51·33	28·27

SET 30 : Morse

Number of signal	Time by chronometer Nieberg	Malta sidereal time ; signals *sent*	Corresponding Berlin sidereal time ; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	15 13 40·0	11 56 49·69	11 52 21·38	0 4 28·31
2	50·0	59·71	31·48	28·23
3	14 0·0	57 9·74	41·48	28·26
4	10·0	19·77	51·53	28·24
5	20·0	29·80	53 1·58	28·22
6	30·0	39·82	11·53	28·29
7	40·0	49·85	21·48	28·37
8	50·0	59·88	31·53	28·35
9	15 0·0	58 9·91	41·58	28·33
10	10·0	19·93	51·58	28·35
11	20·0	29·96	54 1·58	28·38
12	30·0	39·99	11·63	28·36
13	40·0	50·02	21·63	28·39
14	50·0	59 0·04	31·73	28·31
15	15 16 1·0	11 59 11·07	11 54 42·78	28·29

1875, MARCH 15 (*continued*)

SET 31 : Relay

Number of signal	Time by chronometer Nieberg	Malta sidereal time ; signals *sent*	Corresponding Berlin sidereal time ; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	15 36 50·0	12 20 3·50	12 15 35·27	0 4 28·23
2	37 0·0	13·53	45·32	28·21
3	10·0	23·56	55·37	28·19
4	20·0	33·59	16 5·27	28·32
5	30·0	43·62	15·37	28·25
6	40·0	53·65	25·37	28·28
7	50·0	21 3·68	35·42	28·26
8	38 0·0	13·70	45·47	28·23
9	10·0	23·73	55·42	28·31
10	20·0	33·76	17 5·47	28·29
11	30·0	43·79	15·46	28·33
12	40·0	53·81	25·46	28·35
13	50·0	22 3·84	35·46	28·38
14	39 0·0	13·87	45·51	28·36
15	10·0	23·90	55·51	28·39
16	20·0	33·92	18 5·56	28·36
17	30·0	43·95	15·61	28·34
18	40·0	53·98	25·61	28·37
19	50·0	23 4·01	35·66	28·35
20	40 1·0	15·03	46·65	28·38
21	10·0	24·06	55·70	28·36
22	20·0	34·09	19 5·70	28·39
23	15 40 30·0	12 23 44·11	12 19 15·75	28·36

SET 32 : Morse

Number of signal	Time by chronometer Nieberg	Malta sidereal time ; signals *sent*	Corresponding Berlin sidereal time ; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	15 40 50·0	12 24 4·17	12 19 35·85	0 4 28·32
2	41 0·0	14·20	45·90	28·30
3	10·0	24·22	55·90	28·32
4	20·0	34·25	20 5·95	28·30
5	30·0	44·28	15·95	28·33
6	40·0	54·31	25·94	28·37
7	50·0	25 4·33	35·94	28·39
8	42 0·0	14·36	45·99	28·37
9	10·0	24·39	55·99	28·40
10	20·0	34·42	21 6·04	28·38
11	30·0	44·44	16·09	28·35
12	40·0	54·47	26·04	28·43
13	43 0·0	26 14·53	46·24	28·29
14	10·0	24·55	56·24	28·31
15	20·0	34·58	22 6·23	28·35
16	15 43 30·0	12 26 44·61	12 22 16·23	28·38

1875, MARCH 15 (*continued*)

SET 33

Number of signal	Time by chronometer Nieberg	Malta sidereal time ; signals *received*	Corresponding Berlin sidereal time ; signals *sent*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	15 51 23·2	12 34 39·11	12 30 10·39	0 4 28·72
2	33·1	49·04	20·39	28·65
3	43·1	59·07	30·39	28·68
4	53·1	35 9·09	40·39	28·70
5	52 3·0	19·02	50·39	28·63
6	23·0	39·08	31 10·38	28·70
7	33·0	49·10	20·38	28·72
8	43·0	59·13	30·38	28·75
9	53·0	36 9·16	40·38	28·78
10	53 3·0	19·19	50·38	28·81
11	12·9	29·11	32 0·38	28·73
12	22·9	39·14	10·38	28·76
13	32·8	49·07	20·38	28·69
14	42·8	59·10	30·38	28·72
15	53·8	37 10·13	41·38	28·75
16	54 2·7	19·05	50·37	28·68
17	12·7	29·08	33 0·37	28·71
18	22·7	39·10	10·37	28·73
19	32·6	49·03	20·37	28·66
20	42·6	59·06	30·37	28·69
21	53·6	38 10·09	41·37	28·72
22	55 3·6	20·12	50·37	[29·75*]
23	12·5	29·04	34 0·37	28·67
24	22·5	39·07	10·37	28·70
25	32·5	49·10	20·37	28·73
26	42·5	59·12	30·37	28·75
27	52·5	39 9·15	40·36	28·79
28	56 2·5	19·18	50·36	28·82
29	12·4	29·10	35 0·36	28·74
30	22·4	39·13	10·36	28·77
31	32·3	49·06	20·36	28·70
32	42·3	59·09	30·36	28·73
33	52·2	40 9·01	40·36	28·65
34	57 2·2	19·04	50·36	28·68
35	12·2	29·07	36 0·36	28·71
36	22·2	39·10	10·36	28·74
37	32·2	49·12	20·36	28·76
38	42·1	59·05	30·35	28·70
39	52·1	41 9·08	40·35	28·73
40	58 2·1	19·11	50·35	28·76
41	12·1	29·13	37 0·35	28·78
42	15 58 22·0	12 41 39·06	12 37 10·35	28·71

[*] Discordant ; rejected.

Taking the means of the results of the foregoing sets, we obtain :—

Difference of Longitude by signals sent from Malta and recorded at Berlin.

Date	Set	No. of signals	h. m. s.	Instrument	Resulting longitude, Malta east of Berlin By 'Morse' inst. h. m. s.	By 'Relay' inst. h. m. s.
1875, March 10 . .	1	46	0 4 28·133	Morse		
,, ,, . .	4	60	28·151	Morse	0 4 28·142	...
,, March 11 . .	5	53	0 4 28·096	Morse	0 4 28·096	...
,, March 12 . .	8	36	0 4 28·144	Morse		
,, ,, . .	9	35	28·170	Relay		
,, ,, . .	10	36	28·326	Relay		
,, ,, . .	11	35	28·283	Morse	0 4 28·214	0 4 28·248
,, March 14 . .	14	32	0 4 28·043	Morse		
,, ,, . .	15	32	28·088	Relay		
,, ,, . .	16	36	28·189	Morse		
,, ,, . .	17	27	28·209	Relay	0 4 28·116	0 4 28·148
,, March 15 . .	19	17	0 4 28·354	Morse		
,, ,, . .	20	23	28·390	Relay		
,, ,, . .	22	11	28·357	Morse		
,, ,, . .	23	28	28·391	Relay		
,, ,, . .	26	18	28·364	Morse		
,, ,, . .	27	24	28·342	Relay		
,, ,, . .	29	24	28·309	Relay		
,, ,, . .	30	15	28·312	Morse		
,, ,, . .	31	23	28·317	Relay		
,, ,, . .	32	16	28·349	Morse	0 4 28·347	0 4 28·350

On comparing the two kinds of signals, we obtain :—

'Relay'–'Morse' . . . . . = +0ˢ·012*

Or, reducing all the sets to the 'Relay,' we have :—

Date	h. m. s.		h. m. s.
1875, March 10. . . .	0 4 28·154		0 4 28·154
,, March 11. . . .	28·108		28·108
,, March 12. . . .	28·226	}	28·237
,, ,, ...	28·248		
,, March 14. . . .	28·128	}	28·138
,, ,, ...	28·148		
,, March 15. . . .	28·359	}	28·354
,, ,, ...	28·350		

Difference of Longitude by signals sent from Berlin and recorded at Malta.

Date	Set	No. of signals	By 'Relay' h. m. s.	Resulting longitude, Malta east of Berlin h. m. s.
1875, March 10. . .	2	56	0 4 28·609	
,, ,, . . .	3	53	28·673	0 4 28·641
,, March 11. . .	6	54	0 4 28·496	0 4 28·496
,, March 12. . .	7	55	0 4 28·678	
,, ,, . . .	12	56	28·697	0 4 28·688
,, March 14. . .	13	57	0 4 28·496	
,, ,, . . .	18	61	28·617	0 4 28·556
,, March 15. . .	21	31	0 4 28·703	
,, ,, . . .	24	16	28·716	
,, ,, . . .	25	43	28·708	
,, ,, . . .	28	43	28·728	
,, ,, . . .	33	41	28·722	0 4 28·715

* This includes result on p. 391.

Combining these results on the supposition that the current time is the same in both directions, and weighting each day according to the completeness of the sets and the time determinations, we have :—

Date		h.	m.	s.	Weight		s.	Weight
1875, March 10 .	Malta east of Berlin	0	4	28·398	2	Current time	0·244	2
„ March 11 .	„ „			28·302	1	„	0·194	1
„ March 12 .	„ „			28·462	3	„	0·226	2
„ March 14 .	„ „			28·347	3	„	0·209	2
„ March 15 .	„ „			28·534	3	„	0·180	3

Or :—

	h.	m.	s.
Malta east of Berlin	0	4	28·43
Personal equation between Dr. Becker and Dr. Löw in observing transits * . .			− 0·15
Personal equation between Professor Auwers and Dr. Löw in sending signals † . .			+ 0·04

Or, finally :—

	h.	m.	s.
Malta east of Berlin	0	4	28·32

And :—

Current time . . . . 0ˢ·207‡

As will be seen in the finally adopted longitude of Alexandria (p. 348), the signals exchanged between Malta and Berlin on March 13 have been used. As they have not previously been given, we append them here, together with the local sidereal times of the two stations and the resulting difference of longitude :—

SET 12*a* : Morse

Number of signal	Time by chronometer Nieberg	Malta sidereal time ; signals *sent*	Corresponding Berlin sidereal time ; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	16 7 10·0	12 42 34·62	12 38 6·53	0 4 28·09
2	20·0	44·65	16·62	28·03
3	30·0	54·68	26·57	28·11
4	40·0	43 4·71	36·62	28·09
5	50·0	14·73	46·62	28·11
6	8 0·0	24·76	56·72	28·04
7	10·0	34·79	39 6·77	28·02
8	20·0	44·82	16·77	28·05
9	30·0	54·84	26·77	28·07
10	40·0	44 4·87	36·82	28·05
11	9 0·0	24·92	56·86	28·06
12	10·0	34·95	40 6·91	28·04
13	30·0	55·01	27·01	28·00
14	16 40·0	52 6·19	47 38·17	28·02
15	50·0	16·22	48·22	28·00
16	17 0·0	26·25	58·27	27·98
17	16 17 10·0	12 52 36·28	12 48 8·27	28·01

* See end of Chapter XVIII. † Supplied by Professor Auwers. ‡ Result on p. 391 included.

SET 12*a*: Morse (*continued*)

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
18	16 17 20·0	12 52 46·31	12 48 18·27	0 4 28·04
19	30·0	56·33	28·27	28·06
20	40·0	53 6·36	38·31	28·05
21	50·0	16·39	48·31	28·08
22	18 0·0	26·42	58·46	27·96
23	10·0	36·44	49 8·41	28·03
24	19 1·0	54 27·58	59·56	28·02
25	50·0	55 16·72	50 48·75	27·97
26	20 0·0	26·74	58·80	27·94
27	10·0	36·77	51 8·70	28·07
28	20·0	46·80	18·75	28·05
29	30·0	56·83	28·75	28·08
30	40·0	56 6·85	38·80	28·05
31	50·0	16·88	48·85	28·03
32	21 0·0	26·91	58·90	28·01
33	22 30·0	57 57·15	53 29·14	28·01
34	40·0	58 7·18	39·09	28·09
35	50·0	17·21	49·08	28·13
36	23 0·0	27·24	59·23	28·01
37	10·0	37·27	54 9·13	28·14
38	20·0	47·30	19·23	28·07
39	30·0	57·33	29·23	28·10
40	40·0	59 7·35	39·23	28·12
41	50·0	17·38	49·28	28·10
42	24 0·0	27·41	59·33	28·08
43	10·0	37·44	55 9·38	28·06
44	20·0	47·46	19·43	28·03
45	25 1·0	13 0 28·58	56 0·52	28·06
46	26 0·0	1 27·74	59·67	28·07
47	10·0	37·76	57 9·72	28·04
48	20·0	47·79	19·72	28·07
49	30·0	57·82	29·66	28·16
50	40·0	2 7·85	39·71	28·14
51	50·0	17·87	49·81	28·06
52	16 27 0·0	13 2 27·90	12 57 59·86	28·04

SET 12*b*: Relay

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	16 10 50·0	12 46 15·24	12 41 47·25	0 4 27·99
2	11 0·0	25·26	57·30	27·96
3	10·0	35·29	42 7·20	28·09
4	20·0	45·32	17·25	28·07
5	30·0	55·35	27·20	28·15
6	16 11 40·0	12 47 5·37	12 42 37·30	28·07

SET 12*b*: Relay (*continued*)

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
7	16 11 50·0	12 47 15·40	12 42 47·30	0 4 28·10
8	12 0·0	25·43	57·35	28·08
9	10·0	35·46	43 7·30	28·16
10	20·0	45·48	17·40	28·08
11	30·0	55·51	27·39	28·12
12	40·0	48 5·54	37·39	28·15
13	50·0	15·56	47·64	27·92
14	13 0·0	25·59	57·74	27·85
15	10·0	35·62	44 7·69	27·93
16	20·0	45·65	17·68	27·97
17	30·0	55·67	27·78	27·89
18	40·0	49 5·70	37·78	27·92
19	50·0	15·73	47·83	27·90
20	14 0·0	25·76	57·88	27·88
21	20·0	45·81	45 17·88	27·93
22	16 14 30·0	12 49 55·84	12 45 27·93	27·91

SET 12*c*: Relay

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	17 1 30·0	13 37 3·60	13 32 35·34	0 4 28·26
2	40·0	13·63	45·44	28·19
3	50·0	23·65	55·54	28·11
4	2 1·0	34·68	33 6·54	28·14
5	10·0	43·71	15·64	28·07
6	20·0	53·74	25·69	28·05
7	30·0	38 3·76	35·64	28·12
8	40·0	13·79	45·73	28·06
9	6 50·0	42 24·48	37 56·41	28·07
10	7 1·0	35·51	38 7·41	28·10
11	10·0	44·53	16·46	28·07
12	20·0	54·56	26·51	28·05
13	30·0	43 4·59	36·46	28·13
14	40·0	14·61	46·56	28·05
15	50·0	24·64	56·55	28·09
16	8 0·0	34·67	39 6·55	28·12
17	10·0	44·70	16·60	28·10
18	17 8 20·0	13 43 54·72	13 39 26·65	28·07

SET 12*d*: Morse

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *sent*	Corresponding Berlin sidereal time; signals *received*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	17 3 40·0	13 39 13·95	13 34 45·93	0 4 28·02
2	50·0	23·98	55·83	28·15
3	4 0·0	34·01	35 5·93	28·08
4	10·0	44·04	15·93	28·11
5	20·0	54·06	25·97	28·09
6	30·0	40 4·09	36·02	28·07
7	40·0	14·12	46·07	28·05
8	50·0	24·15	56·02	28·13
9	5 0·0	34·17	36 6·12	28·05
10	10·0	44·20	16·12	28·08
11	20·0	54·23	26·22	28·01
12	10 0·0	45 35·00	41 6·89	28·11
13	10·0	45·02	16·84	28·18
14	20·0	55·05	26·99	28·06
15	30·0	46 5·08	36·94	28·14
16	50·0	25·13	57·04	28·09
17	11 1·0	36·16	42 8·04	28·12
18	10·0	45·19	17·03	28·16
19	17 11 20·0	13 46 55·21	13 42 27·08	28·13

SET 12*e*

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *received*	Corresponding Berlin sidereal time; signals *sent*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	16 29 51·9	13 5 20·27	13 0 51·70	0 4 28·57
2	30 1·8	30·20	1 1·70	28·50
3	21·6	50·05	21·70	28·35
4	31·6	6 0·08	31·69	28·39
5	41·6	10·11	41·69	28·42
6	51·5	20·04	51·69	28·35
7	31 1·5	30·06	2 1·69	28·37
8	12·5	41·09	12·69	28·40
9	21·5	50·12	21·69	28·43
10	41·4	7 10·07	41·69	28·38
11	51·4	20·10	51·69	28·41
12	32 1·3	30·03	3 1·69	28·34
13	11·3	40·05	11·69	28·36
14	21·2	49·98	21·69	28·29
15	31·2	8 0·01	31·69	28·32
16	16 32 41·1	13 8 9·94	13 3 41·69	28·25

SET 12e (*continued*)

Number of signal	Time by chronometer Nieberg	Malta sidereal time ; signals *received*	Corresponding Berlin sidereal time ; signals *sent*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
17	16 32 51·2	13 8 20·06	13 3 51·69	4 0 28·37
18	33 1·1	29·99	4 1·69	28·30
19	12·1	41·02	12·69	28·33
20	31·1	9 0·07	31·68	28·39
21	41·0	10·00	41·68	28·32
22	51·0	20·03	51·68	28·35
23	34 1·0	30·05	5 1·68	28·37
24	11·0	40·08	11·68	28·40
25	21·0	50·11	21·68	28·43
26	30·9	10 0·04	31·68	28·36
27	41·0	10·16	41·68	28·48
28	50·9	20·09	51·68	28·41
29	35 0·8	30·02	6 1·68	28·34
30	11·8	41·05	11·68	[29·37*]
31	20·8	50·07	21·68	28·39
32	31·7	11 1·00	31·68	[29·32*]
33	40·8	10·14	41·68	28·46
34	50·7	20·07	51·68	28·39
35	36 0·7	30·09	7 1·68	28·41
36	10·6	40·02	11·68	28·34
37	20·7	50·15	21·68	28·47
38	30·6	12 0·07	31·67	28·40
39	40·6	10·10	41·67	28·43
40	37 0·4	29·96	8 1·67	28·29
41	10·5	40·08	11·67	28·41
42	20·4	50·01	21·67	28·34
43	30·5	13 0·14	31·67	28·47
44	40·5	10·17	41·67	28·50
45	50·5	20·19	51·67	28·52
46	38 0·5	30·22	9 1·67	28·55
47	10·5	40·25	11·67	28·58
48	20·4	50·18	21·67	28·51
49	30·4	14 0·20	31·67	28·53
50	40·4	10·23	41·67	28·56
51	50·3	20·16	51·67	28·49
52	39 0·2	30·08	10 1·67	28·41
53	11·2	41·11	12·67	28·44
54	20·1	50·04	21·66	28·38
55	16 39 30·1	13 15 0·07	13 10 31·66	28·41

SET 12f

Number of signal	Time by chronometer Nieberg	Malta sidereal time ; signals *received*	Corresponding Berlin sidereal time ; signals *sent*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	16 43 19·7	13 18 50·29	13 14 21·65	0 4 28·64
2	29·7	19 0·32	31·64	28·68
3	39·6	10·25	41·64	28·61
4	49·5	20·17	51·64	28·53
5	44 9·5	40·23	15 11·64	28·59
6	19·4	50·16	21·64	28·52
7	29·4	20 0·18	31·64	28·54
8	39·3	10·11	41·64	28·47
9	49·3	20·14	51·64	28·50
10	16 44 59·2	13 20 30·07	13 16 1·64	28·43

[*] Discordant ; rejected.

SET 12*f* (*continued*)

Number of signal	Time by chronometer Nieberg	Malta sidereal time; signals *received*	Corresponding Berlin sidereal time; signals *sent*	Resulting longitude, Malta east of Berlin
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
11	16 45 10·2	13 20 41·09	13 16 12·63	0 4 28·46
12	19·2	50·12	21·63	28·49
13	39·1	21 10·07	41·63	28·44
14	49·1	20·10	51·63	28·47
15	59·1	30·13	17 1·63	28·50
16	46 9·1	40·16	11·63	28·53
17	19·0	50·08	21·63	28·45
18	29·0	22 0·11	31·63	28·48
19	39·0	10·14	41·63	28·51
20	49·0	20·17	51·63	28·54
21	59·0	30·19	18 1·62	28·57
22	47 9·9	41·12	11·62	[29·50*]
23	18·9	50·15	21·62	28·53
24	28·8	23 0·07	31·62	28·45
25	38·8	10·10	41·62	28·48
26	48·7	20·03	51·62	28·41
27	58·7	30·06	19 1·62	28·44
28	48 18·7	50·11	21·62	28·49
29	28·7	24 0·15	31·62	28·53
30	38·6	10·08	41·61	28·47
31	48·6	20·10	51·61	28·49
32	58·6	30·13	20 1·61	28·52
33	49 18·5	50·09	21·61	28·48
34	48·5	25 20·17	51·61	28·56
35	58·5	30·19	21 1·61	28·58
36	50 8·4	40·12	11·61	28·51
37	18·4	50·15	21·61	28·54
38	28·4	26 0·18	31·60	28·58
39	38·4	10·20	41·60	28·60
40	48·3	20·13	51·60	28·53
41	58·3	30·16	22 1·60	28·56
42	51 18·2	50·11	21·60	28·51
43	28·2	27 0·14	31·60	28·54
44	38·1	10·07	41·60	28·47
45	48·2	20·19	51·60	28·59
46	58·1	30·12	23 1·60	28·52
47	52 18·0	50·08	21·59	28·49
48	28·0	28 0·10	31·59	28·51
49	38·0	10·13	41·59	28·54
50	48·0	20·16	51·59	28·57
51	57·9	30·09	24 1·59	28·50
52	16 53 8·8	13 28 41·02	13 24 11·59	[29·43*]

[*] Discordant; rejected.

Taking the means, we have:—

By signals sent from Malta and recorded at Berlin.

Set	No. of signals		Instrument	Resulting longitude, Malta east of Berlin By 'Morse' inst.	By 'Relay' inst.
		h. m. s.		h. m. s.	h. m. s.
12*a*	52	0 4 28·054	Morse		
12*b*	22	28·005	Relay		
12*c*	18	28·103	Relay		
12*d*	19	28·096	Morse	0 4 28·075	0 4 28·054

Or, reducing to the 'Relay' :—

	h.	m.	s.		h.	m.	s.
Malta east of Berlin	0	4	28·087	}	0	4	28·070
			28·054	}			

By signals sent from Berlin and recorded at Malta.

Set	No. of signals	Resulting longitude, Malta east of Berlin By 'Relay'		
		h. m. s.		h. m. s.
12*e*	53	0 4 28·409		...
12*f*	50	28·519		0 4 28·556

Which, combined as usual, gives :—

	h.	m.	s.
Malta east of Berlin	0	4	28·267

And combining this with the results on p. 386, giving each equal weight, we get :—

	h.	m.	s.
Malta east of Berlin	0	4	28·355
Personal equations as on p. 386			−0·110

Therefore :—

	h.	m.	s.
Malta east of Berlin	0	4	28·245*

The following signals between Alexandria and Berlin were observed by Dr. Löw as they passed through the Relay at Malta :—

1875, MARCH 10. (From Alexandria to Berlin.)

Number of signal	Time by chronometer Nieberg			Corresponding Malta sidereal time			Berlin sidereal time			Alexandria sidereal time			Malta east of Berlin			Alexandria east of Malta		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	18	53	40·3	15	17	41·35	15	13	13·29	16	19	11·20	0	4	28·06	1	1	29·85
2			50·2			51·28			23·52			21·20			27·76			29·92
3		54	0·2		18	1·31			33·34			31·20			27·97			29·89
4			10·1			11·23			43·27			41·20			27·96			29·97
5			21·1			22·26			54·30			52·20			27·96			29·94
6			30·1			31·30		14	3·43		20	1·20			27·87			29·90
7			40·0			41·23			13·50			11·20			27·73			29·97
8		55	21·0		19	22·34			54·51			52·21			27·83			29·87
9			30·0			31·36		15	3·49		21	1·21			27·87			29·85
10		56	0·0		20	1·44			33·47			31·21			27·97			29·77
11			10·0			11·47			43·40			41·21			28·07			29·74
12			20·9			22·40			54·43			52·21			27·97			29·81
13			29·8			31·33		16	3·45		22	1·21			27·88			29·88
14			40·0			41·55			13·38			11·21			28·17			29·66
15	18	56	49·8	15	20	51·38	15	16	23·36	16	22	21·21			28·02			29·83

* This result has only been used for the finally adopted longitude of Alexandria. See p. 348.

PASSING SIGNALS OBSERVED BY DR. LÖW (*continued*).

1875, MARCH 10. (From Berlin to Alexandria.)

Number of signal	Time by chronometer Nieberg	Corresponding Malta sidereal time	Berlin sidereal time	Alexandria sidereal time	Malta east of Berlin	Alexandria east of Malta
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m s.
1	19 2 37·5	15 26 40·03	15 22 11·68	16 28 11·51	0 4 28·35	1 1 31·48
2	3 7·4	27 10·01	41·76	41·62	28·25	31·61
3	27·5	30·17	23 1·82	29 1·72	28·35	31·55
4	47·4	50·12	21·87	21·92	28·25	31·80
5	4 27·4	28 30·23	24 1·98	30 1·92	28·25	31·69
6	37·5	40·37	12·01	11·92	28·36	31·55
7	47·4	50·30	22·03	22·02	28·27	31·72
8	5 7·5	29 10·45	42·09	41·92	28·36	31·47
9	17·6	20·58	52·12	52·02	28·46	31·44
10	27·6	30·61	25 2·14	31 2·02	28·47	31·41
11	6 17·4	30 20·55	52·28	52·12	28·27	31·57
12	47·6	50·83	26 22·36	32 22·22	28·47	31·39
13	58·4	31 1·66	33·39	33·22	28·27	31·56
14	7 7·5	10·78	42·42	42·32	28·36	31·54
15	17·5	20·81	52·46	52·22	28·35	31·41
16	19 7 27·5	15 31 30·84	15 27 2·48	16 33 2·32	28·36	31·48

Taking the means of the results, we find :—

	From Berlin	From Alexandria
	h. m. s.	h. m. s.
Malta east of Berlin	0 4 28·341	0 4 27·939
Alexandria east of Malta	1 1 31·542	1 1 29·857

Or :—

	h. m. s.		s.
Malta east of Berlin	0 4 28·140	Current time	0·201
Alexandria east of Malta	1 1 30·700	„	0·843

Therefore :—

	h. m. s.
Alexandria east of Berlin	1 5 58·84
Personal equation between Dr. Becker and Mr. Gill in observing transits * . . .	− 0·21
Personal equation between Professor Auwers and Mr. Gill in sending signals † . .	+ 0·02

Therefore we have from these signals only :—

	h. m. s.
Alexandria east of Berlin	1 5 58·65

And :—

Current time . . . . 1·044

* Becker—Löw . . . . . −0ˢ·15 (chap. xviii.)
Löw—Gill . . . . . −0ˢ·06 (page 349).

† From result supplied by Professor Auwers (p. 433) combined with Mr. Gill's result given in chap. xix. By an oversight an erroneous value of this personal equation has been used on p. 346 ; it ought there also to be +0ˢ·02 and the difference of meridians consequently 1ʰ 5ᵐ 58ˢ·75.

CHAPTER XVIII.

OPERATIONS AT BERLIN.

THE observations at Berlin afford the corrections of the chronometers used in the exchanges of telegraphic longitude signals with Alexandria and Malta, as well as the difference of personal equation between the two Berlin observers, Drs. Knorre and Becker.

On the arrival of Dr. Löw at Berlin, he determined the difference of personal equation between himself and Dr. Becker.

CLOCK AND CHRONOMETER COMPARISONS AT BERLIN.

COMPARISONS OF TIEDE 340 WITH TIEDE 3 (THE TRANSIT CLOCK) BY COINCIDENT BEATS.

Date, 1875	Tiede 3			Tiede 340			Date, 1875	Tiede 3			Tiede 340		
	h.	m.	s.	h.	m.	s.		h.	m.	s.	h.	m.	s.
Feb. 28	10	12	55·0	11	39	0·5	March 11 (*cont.*)	12	31	10·0	13	13	27·5
	10	36	50·0	12	2	51·5		12	34	0·0	13	16	17·0
	15	6	9·0	16	31	26·0							
	15	9	8·0	16	34	24·5	March 12	10	16	9·0	10	54	49·5
								10	19	7·0	10	57	47·0
March 6	10	19	0·0	11	21	26·5		12	1	50·0	12	40	13·0
	10	42	50·0	11	45	12·5		12	4	53·0	12	43	15·5
	11	31	15·0	12	33	29·5		16	18	33·0	16	56	13·5
	13	14	22·0	14	16	19·5		16	21	44·0	16	59	24·0
	14	57	19·0	15	58	59·5		17	13	3·0	17	50	34·5
							March 13	10	1	55·0	10	36	38·0
March 7	10	19	5·0	11	17	35·0		10	4	45·0	10	39	27·5
	[10	22	0·0	11	20	39·5*]		14	45	44·0	15	19	40·0
	11	37	33·0	12	35	50·0		14	48	50·0	15	22	45·5
	13	11	8·0	14	9	9·5							
	14	12	0·0	15	9	51·5	March 14	10	18	40·0	10	49	21·5
								10	21	29·0	10	52	10·0
March 10	10	28	50·0	11	15	27·5		11	46	6·0	12	16	33·0
	10	34	45·0	11	21	21·5		11	49	24·0	12	19	50·5
	11	58	56·0	12	45	18·5		15	54	24·0	16	24	10·0
	12	1	59·0	12	48	21·0		15	57	15·0	16	27	0·5
	15	36	54·0	16	22	40·5							
	15	40	9·0	16	25	55·0	March 15	10	8	5·0	10	34	49·5
								10	11	11·0	10	37	55·0
March 11	9	50	55·0	10	33	39·0		12	45	15·0	13	11	33·5
	9	54	5·0	10	36	48·5		12	51	23·0	13	17	40·5

[*] One comparison 10ˢ wrong ; rejected.

COMPARISONS OF HALF-CHRONOMETER S WITH TIEDE 340 BY COINCIDENT BEATS.

Date, 1875	Tiede 340			S			Date, 1875	Tiede 340			S		
	h.	m.	s.	h.	m.	s.		h.	m.	s.	h.	m.	s.
Feb. 28	11	42	50·0	10	27	26·5	March 12	10	41	37·0	10	17	47·0
	11	54	0·0	10	38	38·5		11	1	40·0	10	37	53·5
	11	59	40·0	10	44	19·5		11	16	19·0	10	52	35·0
	12	16	33·0	11	1	15·5		11	22	4·0	10	58	21·0
	12	33	25·0	11	18	10·5		11	33	52·0	11	10	11·0
	13	16	15·0	12	1	8·0		12	0	10·0	11	36	33·5
	13	22	0·0	12	6	54·0		12	11	35·0	11	48	0·5
	14	7	0·0	12	52	2·0		12	49	40·0	12	26	12·0
	14	18	26·0	13	3	30·0		14	22	57·0	13	59	45·0
	14	30	44·0	13	14	50·0		14	25	50·0	14	2	38·5
	14	35	43·0	13	20	50·0		14	48	44·0	14	25	36·5
	14	40	52·0	13	26	0·0		15	2	55·0	14	39	50·0
	15	0	10·5	13	45	22·0							
	15	41	25·0	14	26	44·0	March 14	11	2	30·0	7	34	28·5
	[16	12	42·0	14	57	6·5]		11	15	7·5	7	47	8·0
	16	14	0·0	14	58	25·0		11	43	30·0	8	15	35·0
	16	35	42·0	15	21	11·0		11	52	45·0	8	24	51·5
								12	11	32·0	8	43	41·5
								13	19	45·0	9	51	55·5
March 10	11	26	35·0	10	54	21·5		13	35	4·0	10	7	27·0
	11	29	33·0	10	57	20·0		14	2	55·0	10	35	22·5
	11	41	6·0	11	10	55·0		14	6	2·0	10	38	30·0
	11	52	22·0	11	20	13·0		14	18	30·0	10	51	0·0
	12	21	10·0	11	49	6·0		14	30	50·0	11	3	22·0
	12	53	5·0	12	21	6·5							
	14	48	38·0	14	16	59·5	March 15	10	43	36·0	7	19	35·0
	15	2	36·0	14	31	0·0		10	46	30·5	7	22	30·0
	15	16	44·0	14	45	10·5		10	57	40·5	7	33	42·0
	15	19	22·0	14	47	49·0		11	11	51·0	7	47	55·0
								11	20	34·5	7	56	40·0
								11	37	48·0	8	13	56·5
March 11	10	41	46·0	10	12	42·0		11	40	43·0	8	16	52·0
	10	44	40·0	10	15	36·5		12	3	42·0	8	39	55·0
	11	15	43·0	10	47	45·0		12	24	30·0	9	0	46·5
	11	27	36·0	10	59	40·0		12	39	1·0	9	15	20·0
	11	39	34·0	11	11	40·0		12	50	44·0	9	27	5·0
	11	45	23·0	11	17	30·0		12	53	28·5	9	29	50·0
	14	57	0·0	14	29	40·0		13	5	12·0	9	41	35·5

TIME DETERMINATIONS AT BERLIN.

The observations for time were taken with the Berlin transit circle and the transit clock Tiede 3, using the chronograph for quick-moving stars. The instrument was not reversed, but remained in the same position (Arm West) throughout. The observations were taken by Dr. Knorre and Dr. Becker, who are designated by their respective initials in the column headed 'Observer.'

Date, 1875	Name of star	Observer	Seconds of transit over the wires							
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.
			s.	s.	s.	s.	s.	s.	s.	s.
Feb. 25	α Orionis	K	...	...	...	36·70	40·78	44·73	52·67	56·64
	δ Ursæ min. S.P.	,,	...	...	...	...	...	...	...	...
	μ Geminorum	,,	...	...	...	33·80	38·20	42·42	50·90	55·22
	ι Ursæ maj.	,,	11·27	17·27	23·30	34·85	40·77	46·78	58·50	4·62
	19 Leonis min.	,,	...	...	...	...	...	...	...	...
Feb. 28	ε Tauri	K	...	...	...	27·78	32·03	36·20	44·37	48·64
	α Tauri	,,	...	...	...	54·12	58·27	2·47	10·60	14·68
	ι Aurigæ	,,	...	...	...	...	...	...	13·90	18·80
	α Aurigæ	,,	...	...	...	...	...	...	45·38	51·17
	α Orionis	,,	...	...	...	35·05	39·11	43·02	50·99	54·98
	δ Ursæ min. S.P.	,,	...	...	...	...	...	...	...	...
	6 Cancri	,,	...	...	...	57·54	1·88	6·48	15·30	19·72
	δ Cancri	,,	28·17	32·30	36·48	44·70	48·88	53·00	1·30	5·48
	o Leonis	,,	24·08	27·98	32·10	40·03	44·01	47·99	56·00	59·97
	α Leonis	,,	...	...	...	53·86	58·00	1·97	9·99	14·06
	ρ Leonis	,,	...	...	...	24·97	28·97	33·10	40·99	44·97
March 1	ε Tauri	K	...	...	...	27·15	31·31	35·50	43·70	47·94
	α Tauri	,,	...	...	...	53·53	57·60	1·66	9·90	14·15
	ι Aurigæ	,,	...	...	...	54·73	59·46	4·12	13·46	18·11
	α Aurigæ	,,	...	...	...	22·26	28·15	33·81	44·89	50·75
March 5	ε Tauri	K	...	...	...	24·70	28·98	33·19	41·40	45·67
	α Tauri	,,	...	...	...	51·11	55·26	59·40	7·57	11·78
	α Aurigæ	,,	...	...	...	...	...	...	42·69	48·47
	α Orionis	,,	...	...	...	32·27	36·00	40·01	48·00	52·04
	δ Ursæ min. S.P.	,,	...	...	...	...	...	...	...	...
March 6	ε Tauri	K	...	...	...	24·21	28·41	32·57	40·72	44·99
	α Tauri	,,	...	...	...	50·55	54·67	58·79	6·95	11·06
	α Aurigæ	,,	...	...	...	19·36	25·02	30·80	42·01	47·78
	α Orionis	,,	...	...	...	31·50	35·55	39·47	47·33	51·36
	δ Ursæ min. S.P.	,,	...	...	...	...	...	...	...	...
	α Leonis	,,	...	...	...	50·51	54·49	58·59	6·50	10·58
	ρ Leonis	,,	...	...	...	21·69	25·60	29·56	37·60	41·76
March 7	β Cancri	K	...	...	...	...	...	...	...	...
	η Cancri	,,	...	...	...	33·90	38·19	42·37	50·78	54·96
	ε Hydræ	,,	...	...	...	16·48	20·56	24·57	32·33	36·47
	ι Ursæ maj.	,,	...	...	...	29·20	35·36	41·21	52·93	59·01
March 9	δ Ursæ min. S.P.	K	29·30	21·88	...	...	...	...	...	...
	64 Aurigæ	,,	...	...	...	15·73	21·10	26·21	36·50	41·80
	ι Geminorum	,,	...	...	...	59·51	3·86	8·36	17·23	21·71
	β Canis min.	,,	...	...	...	...	...	...	...	...
	α Canis min.	,,	...	...	...	51·39	55·38	59·40	7·30	11·20
	β Geminorum	,,	...	...	...	41·75	...	...	59·39	...

Seconds of transit over the wires

IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.
s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
0·56	8·42	12·41	16·34	24·20	28·22	32·12	40·03	44·02	48·01	...	...	...
...	...	14·70	7·44	49·32	49·16	45·55	31·80	24·87	19·04	6·63	59·82	55·13
59·53	7·95	12·33	16·54	24·98	29·13	33·43	41·89	46·17	50·42	...	...	...
10·58	22·36	28·25	34·20	...	...	...	...	...	...	...	...	...
...	45·79	51·01	56·25	6·80	11·82	17·24	27·80	32·85	38·12	48·64	54·08	59·17
52·84	0·94	5·20	9·36	17·59	21·73	25·96	34·12	38·36	42·50	...	...	...
18·83	26·89	30·98	35·08	43·24	47·33	51·43	59·60	3·70	7·80	...	...	...
23·46	32·70	37·39	42·04	51·47	56·14	0·79	10·11	14·76	19·47	...	...	...
56·81	8·10	13·80	19·38	30·70	36·36	41·90	53·30	58·65	4·32	...	...	...
58·98	6·70	10·74	14·77	22·63	26·60	30·50	38·42	42·43	46·46	...	...	...
...	...	13·70	7·29	55·20	51·01	43·33	31·16	26·89	19·00	...	...	...
24·25	33·12	37·70	42·13	51·03	55·55	59·87	8·63	13·22	17·63	...	...	...
9·58	17·98	22·01	26·27	34·40	38·48	42·68	...	...	...	...	...	...
4·00	11·99	15·90	19·83	27·74	31·89	35·65	...	...	...	...	...	...
18·08	26·18	29·96	34·13	42·02	46·08	50·12	58·17	2·22	6·22	...	...	...
49·03	57·07	1·11	4·98	13·05	16·73	20·86	28·72	32·80	36·90	...	...	...
52·26	0·45	4·46	8·69	16·92	21·06	25·35	33·53	37·67	41·79	...	...	...
18·25	26·35	30·40	34·56	42·73	46·63	50·77	59·03	3·00	7·16	...	...	...
22·71	32·29	36·96	41·50	50·74	55·46	0·17	9·61	14·30	18·92	...	...	...
56·30	7·51	13·15	18·77	30·20	35·70	41·41	52·53	58·32	3·96	...	...	...
49·85	58·02	2·22	6·40	14·68	18·78	22·95	31·19	35·23	39·49	...	...	...
15·75	23·95	28·07	32·16	40·36	44·40	48·46	56·66	0·70	4·82	...	...	...
54·03	5·21	10·77	16·43	27·80	33·33	38·84	50·26	55·98	1·53	...	...	...
56·00	3·85	7·80	11·78	19·57	23·57	27·57	35·47	39·44	43·44	...	...	...
...	...	11·00	5·48	52·13	45·97	40·35	29·12	21·29	14·96	4·07	57·97	...
49·12	57·41	1·55	5·74	14·00	18·05	22·22	30·55	34·78	38·90	...	...	...
15·18	23·38	27·41	31·56	39·64	43·75	47·80	55·99	0·09	4·14	...	...	...
53·30	4·60	10·10	15·85	27·13	32·70	38·45	49·59	55·19	1·00	...	...	...
55·43	3·32	7·20	11·14	19·00	22·88	26·90	34·81	38·82	42·70	...	...	...
...	...	10·10	4·49	51·17	45·52	39·95	3·20	57·23	51·60	...	...	...
14·73	22·68	26·56	30·75	38·69	42·71	46·72	54·80	58·77	2·80	...	...	...
45·55	53·58	57·43	1·40	9·49	13·40	17·33	25·33	29·28	33·37	...	...	...
...	...	...	...	...	42·77	46·87	54·76	58·72	2·72	10·58	14·60	18·60
59·23	7·63	11·89	16·08	24·49	28·47	32·88	41·07	45·32	49·63	...	...	...
40·45	48·40	52·32	56·21	4·22	8·10	12·07	19·92	23·83	27·88	...	...	...
4·87	16·66	22·64	28·48	40·38	46·30	52·12	4·03	9·90	16·03	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...
46·98	57·44	2·69	7·86	18·06	23·54	28·56	39·01	44·28	49·58	...	...	...
26·37	35·05	39·50	43·93	52·83	57·29	1·73	10·55	15·08	19·60	...	...	...
...	59·84	3·73	7·75	15·63	19·56	23·56	31·61	35·46	39·42	47·36	51·36	55·31
15·20	23·10	...	...	...	...	...	...	...	...	...	...	...
8·52	17·40	...	...	...	...	..	...	...	1·99	10·84	15·48	19·71

OBSERVATIONS WITH THE BERLIN

Date, 1875	Name of star	Observer	Seconds of transit over the wires							
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.
			s.	s.	s.	s.	s.	s.	s.	s.
March 12	α Leonis	K	...	...	...	47·14	51·15	55·21	3·18	7·35
	ζ Leonis	„	...	...	...	46·32	50·62	54·82	3·31	7·78
March 13	33 Boötis	K	...	...	...	...	...	...	...	...
	δ Boötis	„	5·99	10·63	15·40	24·95	29·62	34·50	43·68	48·53
	μ Boötis	„	21·11	26·23	31·12	40·85	46·02	51·04	0·85	6·20
	β Coronæ	„	...	...	...	...	...	...	57·40	2·14
	ν Boötis, 1st	„	...	...	...	18·80	24·23	29·54	39·82	45·20
March 14	α Leporis	B	57·35	1·45	5·58	13·75	17·95	22·03	30·33	34·47
	δ Ursæ min. S.P.	„	34·0	22·45	18·55	...	...	...	...	...
	θ Geminorum	„	10·25	14·98	19·75	29·30	33·85	38·60	...	...
	ζ Geminorum	„	...	...	...	42·83	46·98	51·03	59·55	3·63
	ι Cancri	„	...	...	...	6·75	11·40	15·90	24·85	29·35
	[40 Lyncis*]	K †	3·57	8·43	13·15	22·85	27·55	32·43	41·90	46·80
	„	B								
	10 Leonis min.	„	9·60	14·65	19·60	29·43	34·38	39·35	49·02	54·15
	„	K †								
	[f Leonis*]	„	53·75	58·35	2·90	11·85	16·50	21·25	30·30	34·83
	„	B								
	μ Leonis	„	21·63	26·05	30·43	39·20	43·70	48·10	56·85	1·35
	„	K †								
	[B.A.C. 3423*]	„	34·73	39·20	43·40	51·85	56·15	0·48	8·98	13·20
	„	B								
March 15	δ Ursæ min. S.P.	B	28·05	22·75	16·4	2·8	56·55	49·75	38·85	...
	θ Geminorum	„	...	...	...	28·50	33·25	38·10	47·40	52·27
	ζ Geminorum	„	...	...	...	42·10	46·20	50·47	58·80	3·02
	63 Aurigæ	„	...	...	...	55·95	1·15	6·23	16·25	21·55
	δ Cancri	„	19·47	23·60	27·60	36·03	40·23	44·35	52·55	56·80
	10 Leonis min.	„	...	...	...	28·75	33·77	38·45	48·30	53·40
	μ Ursæ maj.	„	...	...	...	44·55	49·65	55·18	5·70	11·15
March 16	δ Ursæ min. S.P.	B	...	...	...	...	58·00	49·50	39·20	30·90
	θ Geminorum	„	...	...	...	27·75	32·45	37·35	46·70	51·55
	ζ Geminorum	„	...	...	...	41·35	45·60	49·75	58·15	2·40
	β Canis min.	„	...	...	...	23·85	27·95	31·87	39·85	43·88
	β Cancri	„	...	...	...	45·85	50·00	53·98	1·75	5·87
	ι Cancri	„	...	...	...	5·40	9·98	14·45	23·40	28·00
	μ Leonis	„	...	...	...	37·87	42·25	46·70	55·40	0·00
	20 Comæ	„	...	...	...	...	...	...	43·57	47·85
	24 Comæ	„	...	...	...	52·35	56·58	0·77	9·00	13·20
	δ Virginis	„	...	...	...	20·95	24·85	28·77	36·57	40·58
	α Ursæ min. S.P.	„	...	...	...	...	...	...	...	...

[*] Names of stars supplied.

[†] The observations taken by Dr. Knorre on March 14 are used for personal equation.

TRANSIT CIRCLE (*continued*).

Seconds of transit over the wires												
IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.
s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
11·33	19·33	23·37	27·31	35·40	39·43	43·45	51·40	55·50	59·59	...	...	...
12·11	20·69	25·00	29·23	37·82	42·21	46·42	54·99	59·30	3·60	...	...	...
...	45·88	51·42	56·73	7·93	...	19·12	29·77	35·73	41·15	...	...	...
53·21	2·70	7·55	12·12	21·55	26·27	30·93	40·59	45·10	49·86	59·34	4·11	8·80
10·86	20·73	25·83	30·73	40·49	45·56	50·57	0·49	5·50	10·40	...	...	...
6·50	15·39	19·88	24·46	33·54	38·00	42·44	51·42	56·03	0·48	9·39	14·04	18·54
50·42	0·80	6·00	11·27	21·65	26·97	32·20	42·55	47·57	53·02	...	...	...
38·60	...	51·03	...	3·37	7·48	11·55	...	...	...	...	...	44·60
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	11·95	...	26·05	30·80	35·53	44·98	49·80	54·55	...	...	...
7·95	16·38	20·45	24·60	33·10	37·15	41·48	49·80	54·02	58·30	...	...	...
33·98	42·85	47·15	51·60	0·85	5·30	9·85	18·75	23·25	27·78	...	...	...
51·55	...	...	...									
	...	...	..	20·40	25·30	30·05	39·47	44·35	49·13	58·50	3·35	8·30
59·02	...	...	...									
	...	...	...	28·15	33·05	38·05	47·80	52·70	57·60	7·47	12·37	17·25
39·45	...	...	...									
	...	...	...	6·87	11·45	16·00	24·85	29·55	34·30	43·35	47·90	52·45
5·70	...	...	...									
	...	...	...	31·85	36·20	40·60	49·40	53·75	58·25	6·85	11·30	15·60
17·43	...	...	...	...								
	...	...	...	...	47·30	51·60	0·02	4·25	8·65	16·95	21·25	25·45
...	12·4	5·7	0·35	48·8	43·05	...	...	...	...	...	...	...
57·02	...	11·35	...	25·40	30·15	34·85	44·40	49·18	53·85	...	...	...
7·40	...	19·75	...	32·37	36·50	40·63	49·02	53·35	57·55	...	...	...
26·63	...	41·85	...	57·10	2·20	7·27	17·45	22·40	27·65	...	...	...
0·97	...	13·37	...	25·87	29·85	34·15	...	...	...	...	...	...
58·15	...	12·85	...	27·60	32·55	37·43	47·43	52·20	57·17	...	...	...
16·50	27·05	32·30	37·60	...	53·40	58·65	9·02	14·62	19·90	30·37	35·63	40·85
25·20	13·50	7·05	0·20	48·75	42·50	35·90	23·35	18·40	11·85	0·75	...	...
56·37	...	10·45	...	24·60	29·40	34·15	...	...	...	2·50	7·25	12·02
6·55	...	19·15	...	31·60	35·87	40·02	48·45	52·60	56·85	...	...	...
47·85	...	59·67	...	11·53	15·50	19·47	27·40	31·35	35·35	...	...	...
9·90	...	21·65	...	33·60	37·60	41·65	49·57	53·55	57·55	...	...	...
32·45	...	45·85	...	59·40	3·85	8·37	17·37	21·80	26·35	...	...	...
4·37	...	17·40	...	30·70	35·02	39·35	48·13	52·65	56·90	...	...	...
52·15	0·46	4·65	8·96	17·35	21·45	25·67	34·15	38·45	42·55	51·15	55·22	59·55
17·40	...	29·87	...	42·23	46·43	50·47	58·77	2·90	7·10	...	...	...
44·58	...	56·38	...	8·08	12·10	16·00	23·82	27·80	31·65	...	...	...
...	1·3	18·0	30·95	58·5	15·1	28·7	...	...	...	...	...	...

The following observations were taken to determine the difference of personal equation between Dr. Knorre and Dr. Becker :—

Date, 1875	Observer	Seconds of transit over the wires																				
		I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.
		s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
April 5	K	7·45	11·38	15·33	23·15	27·10	31·05	38·90	42·70	46·80	...	...	...	...								
	B										...	...	...	...	14·35	18·35	26·10	30·03	33·98	41·75	45·65	49·77
	„ K	4·05	9·15	14·30	24·50	29·70	34·70	44·85	50·05	55·07	...	...	...									
	„ B										...	...	...	25·50	30·55	35·83	46·00	51·20	56·30	6·33	11·42	16·65
	„ K	0·00	4·13	8·37	16·70	21·02	25·15	33·65	37·95	42·05	...	...	...									
	„ B										...	...	...	7·40	11·70	16·00	24·37	28·63	32·95	41·40	45·50	49·85
	„ K	55·35	59·30	3·30	11·00	...	18·98	26·82	30·75	34·65	...	...	...									
	„ B										...	...	...	58·17	2·03	6·03	13·93	17·95	21·97	29·65	33·55	37·60
	„ K	33·30	37·38	41·38	49·20	53·25	57·35	5·37	9·55	13·37	...	...	...									
											...	...	...	37·43	41·40	45·55	53·65	57·70	1·53	9·55	13·55	17·60
	„ K	42·05	47·02	52·23	2·30	7·33	12·40	22·50	27·55	32·60	...	...	...									
											...	...	...	2·87	7·95	12·98	23·10	28·10	33·35	43·38	48·40	53·63
May 14	K	49·28	54·40	59·54	9·77	14·90	20·03	30·18	35·41	40·42	...	...	...									
	B										...	...	...	11·13	16·11	21·25	31·48	36·55	41·70	51·80	57·00	2·10
	K	37·20	44·93	48·90	52·79	0·60	4·44	8·49	16·24	20·20	24·13	...										
	B										...	42·10	46·11	50·11	57·87	1·84	5·83	13·60	17·55	21·50	...	
	K	39·63	43·74	47·96	56·17	0·32	4·55	12·68	16·92	21·02	...	...	...									
	B										...	...	...	45·88	49·97	54·12	2·28	6·43	10·50	18·87	22·90	27·07
	„ K	14·04	19·57	25·21	36·20	41·85	47·38	58·47	4·01	9·67	...											
											...	26·11	31·69	42·78	48·22	53·90	4·88	10·38	16·02	26·98	32·47	38·04
	„ B	18·46	22·54	26·50	34·27	38·35	42·34	50·04	54·04	58·03	...	...	...									
											...	...	...	21·52	25·50	29·55	37·44	41·25	45·19	52·98	56·88	0·80
	„ K	22·29	26·62	31·07	40·00	44·41	48·92	57·70	2·13	6·62	...											
											...	19·85	24·12	32·98	37·28	41·73	50·60	55·00	59·56	8·21	12·73	17·19

The observations were reduced at the Berlin Observatory, from whence the following details were kindly supplied :—

Observations with the Berlin Transit Circle.

Date				Level	Collimation, including daily aberration	Azimuth	
		h.	m.	s.	s.	s.	
1875, Feb. 25	at	6	20	sid. time −0·373	+0·09	−0·266	
„ „	„	10	0	„ −0·298			
„ Feb. 28	„	5	53	„ −0·382	+0·09	−0·31	
„ „	„	10	8	„ −0·316			
„ March 1	„	4	57	„ −0·484	+0·09	−0·30	
„ March 5	„	5	54	„ −0·514	+0·09	−0·285	
„ March 6	„	5	54	„ −0·535	+0·09	−0·280	
„ March 7	„	8	30	„ −0·523	+0·09	−0·28	
„ March 9	„	6	41	„ −0·678	+0·09	−0·264	
„ March 12	„	10	33	„ −0·549	+0·09	−0·26	
„ March 13	„	14	50	„ −0·565	+0·09	−0·32	
„ March 14	„	5	48	„ −0·582	+0·09	−0·38	
„ „	„	6	35	„ −0·554			
„ „	„	10	10	„ −0·525			
„ March 15	„	6	35	„ −0·550	+0·09	−0·16	
„ „	„	10	25	„ −0·530			
„ March 16	„	6	30	„ −0·517	+0·09	−0·17 from 6 h. 44 m. to 9 h. 46 m. sid. time	
„ „	„	9	55	„ −0·526		−0·18 „ 11 56 „ 12 50 „	
„ „	„	13	28	„ −0·501			

Date, 1875	Epoch by Tiede 3	Observer	Name of star	Seconds of concluded clock time of transit over wire XI.	Sum of instrumental corrections	Seconds of star's R.A.	Clock correction
	h. m.			s.	s.	s.	s.
Feb. 25	7 41·0	K	α Orionis	12·41	−0·36	24·96	+ 12·91
		,,	δ Ursæ min. S.P.	14·30	...	...	...
		,,	μ Geminorum	12·22	−0·39	24·80	12·97
		,,	ι Ursæ maj.	28·32	−0·37	40·91	12·96
		,,	19 Leonis min.	51·01	−0·34	3·65	12·98
Feb. 28	7 6·9	K	ϵ Tauri	5·15	−0·41	19·22	+ 14·48
		,,	α Tauri	31·03	−0·42	45·10	14·49
		,,	ι Aurigæ	37·41	−0·45	51·53	14·57
		,,	α Aurigæ	13·73	−0·47	27·88	14·62
		,,	α Orionis	10·78	−0·40	24·91	14·53
		,,	δ Ursæ min. S.P.	14·06	...	...	...
		,,	6 Cancri	37·63	−0·41	51·82	14·60
		,,	δ Cancri	22·03	−0·39	36·32	14·68
		,,	o Leonis	15·93	−0·37	30·22	14·66
		,,	α Leonis	30·09	−0·37	44·41	14·69
		,,	ρ Leonis	0·97	−0·37	15·22	14·62
March 1	4 41·3	K	ϵ Tauri	4·50	−0·51	19·20	+ 15·21
		,,	α Tauri	30·41	−0·51	45·09	15·19
		,,	ι Aurigæ	36·86	−0·56	51·51	15·21
		,,	α Aurigæ	13·21	−0·61	27·85	15·25
March 5	4 56·2	K	ϵ Tauri	2·16	−0·52	19·14	+ 17·50
		,,	α Tauri	28·07	−0·51	45·02	17·46
		,,	α Aurigæ	10·87	−0·66	27·76	17·55
		,,	α Orionis	7·81	−0·47	24·83	17·49
		,,	δ Ursæ min. S.P.	10·65	...	...	...
March 6	6 42·0	K	ϵ Tauri	1·53	−0·53	19·12	+ 18·12
		,,	α Tauri	27·42	−0·53	45·00	18·11
		,,	α Aurigæ	10·22	−0·69	27·74	18·21
		,,	α Orionis	7·18	−0·49	24·82	18·13
		,,	δ Ursæ min. S.P.	10·04	...	...	...
		,,	α Leonis	26·68	−0·53	44·43	18·28
		,,	ρ Leonis	57·52	−0·52	15·25	18·25
March 7	8 31·2	K	β Cancri	26·93	−0·49	45·39	+ 18·95
		,,	η Cancri	11·82	−0·54	30·17	18·89
		,,	ϵ Hydræ	52·28	−0·48	10·68	18·88
		,,	ι Ursæ maj.	27·64	−0·68	40·84	18·88
March 9	7 23·4	K	δ Ursæ min. S.P.	7·22	...	...	...
		,,	64 Aurigæ	2·65	−0·83	21·84	+ 20·02
		,,	ι Geminorum	39·53	−0·72	58·90	20·09
		,,	β Canis min.	3·77	−0·58	23·29	20·10
		,,	α Canis min.	26·97	−0·57	46·41	20·01
		,,	β Geminorum	21·87	−0·73	41·18	20·04

Date, 1875	Epoch by Tiede 3	Observer	Name of star	Seconds of concluded clock time of transit over wire XI.	Sum of instrumental corrections	Seconds of star's R.A.	Clock correction
	h. m.			s.	s.	s.	s.
March 12	10 5·4	K	α Leonis	23·36	−0·51	44·42	+21·57
		„	ζ Leonis	24·97	−0·57	45·95	21·55
March 13	15 10·3	K	33 Boötis	51·33	−0·71	13·00	+22·38
		„	δ Boötis	7·44	−0·64	29·26	22·46
		„	μ Boötis	25·78	−0·68	47·50	22·40
		„	β Coronæ	19·98	−0·64	41·83	22·49
		„	ν Boötis (prec.)	6·03	−0·69	27·79	22·45
March 14	7 49·6	B	α Leporis	50·99	−0·49	13·32	+22·82
		„	δ Ursæ min. S.P.	9·72	...	...	...
		„	θ Geminorum	11·90	−0·63	33·87	22·60
		„	ζ Geminorum	20·51	−0·61	42·56	22·66
		„	ι Cancri	47·33	−0·63	9·40	22·70
		K	40 Lyncis	5·90	...	...	...
		B	„	6·09	...	...	...
		„	10 Leonis min.	13·67	−0·66	35·69	22·68
		K	„	13·50	...	...	...
		„	f Leonis	53·06	...	...	...
		B	„	53·24	...	...	...
		„	μ Leonis	18·81	−0·61	40·90	22·70
		K	„	18·71	...	...	...
		„	B.A.C. 3423	30·18	...	...	...
		B	„	30·35	...	...	...
March 15	8 10·2	B	δ Ursæ min. S.P.	6·67	...	...	...
		„	θ Geminorum	11·24	−0·58	33·85	+23·19
		„	ζ Geminorum	19·81	−0·49	42·55	23·23
		„	63 Aurigæ	41·85	−0·62	4·47	23·24
		„	δ Cancri	13·36	−0·47	36·21	23·32
		„	10 Leonis min.	12·96	−0·59	35·68	23·31
		„	μ Ursæ maj.	32·25	−0·62	54·99	23·36
March 16	9 28·3	B	δ Ursæ min. S.P.	6·85	...	...	...
		„	θ Geminorum	10·48	−0·55	33·83	+23·90
		„	ζ Geminorum	19·13	−0·47	42·53	23·87
		„	β Canis min.	59·68	−0·41	23·19	23·92
		„	β Cancri	21·76	−0·42	45·29	23·95
		„	ι Cancri	45·92	−0·53	9·38	23·99
		„	μ Leonis	17·46	−0·50	40·89	23·93
		„	20 Comæ	4·70	−0·46	28·34	24·10
		„	24 Comæ	29·80	−0·44	53·39	24·03
		„	δ Virginis	56·34	−0·37	20·03	24·06
		„	α Ursæ min. S.P.	17·10	...	...	...

Before adopting the final clock correction for each day, it will be convenient to deduce the difference of personal equation in observing transits between Dr. Knorre and Dr. Becker, in order to reduce all the time determinations to a common standard. From the observations previously given, we find:—

1875, March 16			April 5			May 14		
Concluded clock seconds of transit over wire by		Dr. Becker *minus* Dr. Knorre	Concluded clock seconds of transit over wire by		Dr. Becker *minus* Dr. Knorre	Concluded clock seconds of transit over wire by		Dr. Becker *minus* Dr. Knorre
Dr. Becker	Dr. Knorre		Dr. Becker	Dr. Knorre		Dr. Becker	Dr. Knorre	
s.	s.	s.	s.	s.	s.	s.	s.	s.
6·09	5·90	+0·19	58·62	58·43	+0·19	55·84	55·72	+0·12
13·67	13·50	+0·17	10·34	10·24	+0·10	33·26	33·19	+0·07
53·24	53·06	+0·18	54·85	54·71	+0·14	33·47	33·39	+0·08
18·81	18·71	+0·10	46·43	46·37	+0·06	26·22	26·13	+0·09
30·35	30·18	+0·17	25·47	25·35	+0·12	9·87	9·74	+0·13
			47·75	47·67	+0·08	19·81	19·74	+0·07

Whence, on taking the means—

	s.
Becker–Knorre, 1875, March 14	+0·162
„ „ „ April 5	+0·115
„ „ „ May 14	+0·093

Therefore, to reduce the observations of Dr. Knorre to the standard of Dr. Becker, we must apply the correction—

	s.
To 'transits'	+0·12

Or—

	s.
To 'clock corrections' . .	−0·12

We can now derive the final clock corrections, reducing all of them to Dr. Becker, with whom Dr. Löw subsequently determined personal equation (see pp. 425–430).

On March 10 and 11, 1875, there were no observations for time at Berlin. The corrections of Tiede 3 for these days have been obtained by interpolating between the comparisons of Tiede 3 and (E) an electric clock going under constant atmospheric pressure, and taking the mean of these interpolations and those given by the observations of March 9 and March 12. The following are the results of comparisons of Tiede 3 with (E):—

Date	h.		(E)–Tiede 3 s.
1875, March 8	at 2·3	sidereal time	+13·54
„ „	„ 14·35	„	12·69
„ March 9	„ 2·4	„	11·73
„ „	„ 7·15	„	11·27
„ „	„ 7·6	„	11·23
„ „	„ 14·4	„	10·88
„ March 10	„ 2·4	„	10·07
„ „	„ 14·5	„	9·37

Date	h.		(E)–Tiede 3 s.
1875, March 11	at 2·5	sidereal time	+8·74
„ March 12	„ 2·6	„	7·47
„ „	„ 10·0	„	7·01
„ „	„ 14·6	„	6·72
„ March 13	„ 2·6	„	5·95
„ „	„ 14·7	„	5·32

From these we derive the following corrections for Tiede 3 on March 10 and 11 :—

Date	h.	m.		s.	s.
1875, March 10, at 11	59·7 by Tiede 3	by comparisons with (E) . .		+20·658	+20·58
		by observations		20·508	
	h.	m.		s.	s.
1875, March 11, at 11	59·7 by Tiede 3	by comparisons with (E) . .		+21·053	+21·02
		by observations		20·993	

Taking the means of each day, and applying the difference of personal equation, we finally obtain corrections and rates of Tiede 3 reduced to Dr. Becker :—

Date	Epoch by Tiede 3 h.	m.	Correction of Tiede 3 to local sidereal time s.	*Hourly* rate s.
1875, Feb. 25	7	41·0	+12·84	
				+0·0228
„ „ 28	7	6·9	14·47	
				+0·0292
„ March 1	4	41·3	15·10	
				...
„ „ 5	4	56·2	17·38	
				+0·0264
„ „ 6	6	42·0	18·06	
				+0·0279
„ „ 7	8	31·2	18·78	
				+0·0245
„ „ 9	7	23·4	19·93	
„ „ 10	11	59·7	20·435	+0·0200
„ „ 11	11	59·7	20·99	+0·0200
„ „ 12	10	5·4	21·44	
				+0·0268
„ „ 13	15	10·3	22·32	
				+0·0222
„ „ 14	7	49·6	22·69	
				+0·0242
„ „ 15	8	10·2	23·28	
				+0·0277
„ „ 16	9	28·3	23·98	

Combining the means of the comparisons of Tiede 3 with Tiede 340 on each day, using the extreme ones for rate, with the foregoing corrections and rates of Tiede 3, we obtain the subsequent corrections and rates for Tiede 340 :—

Date	Epoch by Tiede 340	Correction of Tiede 340 to local mean time	*Hourly* rate
	h. m.	m. s.	s.
1875, Feb. 28	14 11·9	+0 47·86	+0·119
„ March 6	13 11·1	0 53·94	+0·108
„ „ 7	13 18·1	0 55·19	+0·125
„ „ 10	13 29·8	1 0·00	+0·118
„ „ 11	11 55·0	1 4·195	+0·124
„ „ 12	14 8·9	1 8·40	+0·123
„ „ 13	12 59·6	1 12·98	+0·127
„ „ 14	13 11·5	1 16·35	+0·110
„ „ 15	11 55·5	1 19·625	+0·125

Using these corrections and rates, the comparisons of Tiede 340 with chronometer S afford the following corrections for (S) :—

Date, 1875	Epoch by (S)	Correction of (S) to local sidereal time	Date, 1875	Epoch by (S)	Correction of (S) to local sidereal time
	h. m.	m. s.		h. m.	h. m. s.
Feb. 28	11 1·3	−10 27·19	March 12 (*cont.*)	10 52·6	−0 14 31·47
	11 18·2	10 27·39		10 58·4	31·52
	12 1·1	10 27·77		11 10·2	31·56
	12 6·9	10 27·81		11 36·6	31·68
	12 52·0	10 28·33		11 48·0	31·78
	13 3·5	10 28·43		12 26·2	31·95
	13 14·8	[9 28·38*]		14 1·2	32·45
	13 20·8	10 28·55		14 25·6	32·65
	13 26·0	10 28·69		14 39·8	32·79
	13 45·4	10 28·98	March 14	7 34·5	+2 57 44·95
	14 26·7	10 29·63		7 47·1	45·05
	14 58·4	[9 30·21*]		8 15·6	45·27
	15 21·2	10 30·60		8 24·9	45·31
				8 43·7	45·42
March 10	10 55·8	−14 1·70		9 51·9	45·72
	11 10·9	[16 1·65*]		10 7·4	45·79
	11 20·2	14 1·91		10 35·4	45·92
	11 49·1	14 2·13		10 39·5	45·94
	12 21·1	14 2·32		10 51·0	46·01
	14 17·0	14 3·11		11 3·4	46·07
	14 31·0	14 3·29	March 15	7 21·0	+2 57 41·27
	14 46·5	14 3·47		7 33·7	41·12
				7 47·9	40·98
March 11	10 47·8	−14 18·07		7 56·7	40·93
	10 59·7	14 18·09		8 15·4	40·79
	11 11·7	14 18·10		8 39·9	40·60
	11 17·5	14 18·13		9 0·8	40·57
	14 29·7	14 19·26		9 15·3	40·49
March 12	10 17·8	−14 31·24		9 28·5	40·41
	10 37·9	14 31·41		9 41·6	40·34

[*] Discordant ; rejected.

In the foregoing table all the corrections of the half-chronometer S are given, so that the reader can form an idea of the general steadiness of its rate. The corrections required for the times of exchange of signals have always been interpolated between the correction immediately preceding and that immediately following the time required. The corrections of (S) thus obtained, and those of Tiede 340, previously given, applied to the recorded chronometer times of the longitude signals, have afforded the Berlin sidereal times already utilised in Chapters XVI. and XVII.

SIGNALS SENT TO AND RECEIVED FROM ALEXANDRIA.

1875, FEBRUARY 28

Number of signal	SET 1	SET 2	SET 3	SET 4
	Time by chronometer S	Time by chronometer S	Time by chronometer S	Time by chronometer S
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	13 32 1·5	13 37 40·0	13 55 6·0	14 3 10·0
2	11·8	38 0·0	56·2	20·0
3	22·0	20·0	56 6·1	30·0
4	32·0	30·0	26·3	40·0
5	52·0	40·0	36·0	4 10·0
6	33 1·7	39 0·0	56·5	20·0
7	11·7	10·0	57 6·5	30·0
8	21·8	20·0	16·5	40·0
9	52·1	30·0	26·4	5 0·0
10	34 22·0	40·0	36·3	10·0
11	32·3	40 0·0	58 6·6	20·0
12	51·8	10·0	16·5	30·0
13	35 2·3	20·0	26·5	40·0
14	12·4	30·0	36·7	6 0·0
15	22·5	40·0	56 6	10·0
16	32·4	41 0·0	59 16·6	20·0
17	52·5	20·0	27·5	7 0·0
18	36 2·1	40·0	36·6	20·0
19	22·6	50·0	14 0 7·0	14 7 30·0
20	13 36 32·4	42 0·0	16·8	...
21	...	10·0	27·0	...
22	...	20·0	14 0 36·8	...
23	...	13 42 30·0	...	...

1875, FEBRUARY 28 (*continued*)

Number of signal	SET 5	SET 6	SET 7	SET 8
	Time by chronometer S	Time by chronometer S	Time by chronometer S	Time by chronometer S
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 8 58·5	14 15 20·0	14 35 40·0	14 42 4·0
2	9 8·5	30·0	36 0·0	14·1
3	18·2	40·0	10·0	24·1
4	28·5	16 0·0	20·0	34·0
5	38·5	20·0	30·0	44·0
6	58·5	30·0	37 0·0	43 4·2
7	10 8·5	40·0	20·0	14·2
8	18·5	17 0·0	30·0	24·2
9	38·6	10·0	40·0	34·3
10	58·7	20·0	38 0·0	44·3
11	11 8·6	30·0	10·0	44 4·5
12	18·6	40·0	20·0	14·4
13	38·8	18 0·0	30·0	24·3
14	59·0	10·0	40·0	34·4
15	12 9·0	20·0	39 0·0	44·5
16	18·8	30·0	10·0	45 4·5
17	29·0	40·0	20·0	14·5
18	39·1	19 0·0	30·0	24·5
19	59·1	10·0	40·0	34·65
20	13 9·1	20·0	40 0·0	44·6
21	19·3	30·0	10·0	46 4·5
22	14 13 30·0	40·0	20·0	14·7
23	...	14 20 0·0	14 40 30·0	24·75
24	...	...	...	34·8
25	...	...	...	44·8
26	...	...	...	47 5·0
27	...	...	...	14·8
28	...	...	...	24·9
29	...	...	...	35·0
30	...	...	...	45·0
31	...	...	...	48 5·0
32	...	...	...	15·1
33	...	...	...	25·2
34	...	...	...	35·1
35	...	...	...	45·15
36	...	...	...	49 4·5
37	...	...	...	15·3
38	...	...	...	25·3
39	...	...	...	35·5
40	...	...	...	45·3
41	...	...	...	50 5·3
42	...	...	...	15·4
43	...	...	...	25·4
44	...	...	...	35·5
45	...	...	...	45·5
46	...	...	...	51 5·5
47	...	...	...	15·5
48	...	...	...	25·65
49	...	...	...	35·6
50	...	...	...	14 51 45·7

1875, March 6

Number of signal	Set 9	Set 10	Set 11	Set 12
	Time by chronometer Tiede 340	Time by chronometer Tiede 340	Time by chronometer Tiede 340	Time by chronometer Tiede 340
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	13 3 27·0	13 10 20·0	13 17 54·5	13 25 30·0
2	46·9	30·0	18 4·6	40·0
3	56·9	40·0	24·5	50·0
4	4 6·9	50·0	35·5	26 1·0
5	16·8	11 10·0	44·5	10·0
6	26·8	20·0	54·5	20·0
7	46·7	30·0	19 4·45	30·0
8	56·7	40·0	14·4	40·0
9	5 6·7	50·0	35·4	50·0
10	16·6	12 10·0	54·25	27 1·0
11	26·5	30·0	20 4·1	10·0
12	46·5	40·0	14·15	20·0
13	56·6	50·0	24·1	30·0
14	6 6·5	13 1·0	35·1	50·0
15	16·5	10·0	44·0	28 1·0
16	26·5	20·0	21 4·05	10·0
17	46·5	30·0	14·1	20·0
18	56·4	40·0	24·05	30·0
19	7 6·35	50·0	35·0	40·0
20	26·2	14 1·0	44·0	50·0
21	46·1	10·0	53·9	29 1·0
22	56·25	20·0	22 3·9	10·0
23	8 6·1	30·0	13·85	20·0
24	16·1	40·0	23·8	30·0
25	26·1	50·0	34·7	40·0
26	46·1	15 1·0	43·8	50·0
27	56·1	10·0	53·8	30 1·0
28	9 6·1	20·0	23 3·7	10·0
29	16·0	30·0	13·9	20·0
30	13 9 26·0	40·0	23·9	30·0
31	...	50·0	33·7	40·0
32	...	16 1·0	43·6	50·0
33	...	10·0	53·5	13 31 1·0
34	...	20·0	24 3·55	...
35	...	30·0	13·5	...
36	...	13 16 40·0	13 24 23·5	...

1875, MARCH 6 (*continued*)

Number of signal	SET 13	SET 14	SET 15	SET 16
	Time by chronometer Tiede 340	Time by chronometer Tiede 340	Time by chronometer Tiede 340	Time by chronometer Tiede 340
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	13 41 40·5	13 49 10·0	13 56 38·0	14 4 20·0
2	50·8	20·0	48·0	30·0
3	42 0·5	30·0	58·0	40·0
4	10·5	40·0	57 8·0	50·0
5	31·5	50·0	18·0	5 1·0
6	40·5	50 1·0	29·0	10·0
7	50·45	10·0	38·0	20·0
8	43 0·35	20·0	47·9	30·0
9	10·3	30·0	57·9	40·0
10	40·5	40·0	58 7·85	6 1·0
11	50·1	50·0	18·0	10·0
12	44 0·3	51 1·0	28·8	20·0
13	10·3	10·0	37·75	30·0
14	20·1	20·0	47·75	40·0
15	31·3	30·0	57·75	50·0
16	40·2	40·0	59 7·7	7 1·0
17	50·0	50·0	17·7	10·0
18	45 0·0	52 1·0	37·5	20·0
19	10·0	10·0	47·55	30·0
20	19·9	20·0	57·55	40·0
21	30·9	30·0	14 0 7·5	50·0
22	49·9	40·0	17·5	8 1·0
23	59·8	50·0	28·5	10·0
24	46 10·1	53 1·0	37·5	20·0
25	20·0	10·0	47·5	30·0
26	31·0	20·0	57·5	50·0
27	39·8	30·0	1 7·45	9 1·0
28	49·7	40·0	17·45	10·0
29	59·7	50·0	28·45	20·0
30	47 9·75	54 0·0	37·4	30·0
31	39·6	10·0	47·4	40·0
32	49·55	20·0	57·3	50·0
33	59·5	30·0	2 7·25	10 1·0
34	48 9·55	40·0	17·35	20·0
35	13 48 19·5	50·0	37·5	30·0
36	...	13 55 1·0	47·1	40·0
37	...	...	57·05	14 10 50·0
38	...	...	3 7·05	...
39	...	...	14 3 17·05	...

1875, March 7

Number of signal	Set 17	Set 18	Set 19	Set 20
	Time by chronometer Tiede 340	Time by chronometer Tiede 340	Time by chronometer Tiede 340	Time by chronometer Tiede 340
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	12 42 4·5	12 49 30·0	12 57 52·0	13 5 20·0
2	14·3	40·0	58 2·0	30·0
3	24·3	50·0	11·9	40·0
4	34·2	50 1·0	22·0	50·0
5	45·1	10·0	32·9	6 1·0
6	54·1	20·0	59 1·7	10·0
7	43 4·05	30·0	11·7	30·0
8	14·0	50·0	21·6	40·0
9	24·0	51 1·0	31·5	50·0
10	34·0	20·0	42·5	7 1·0
11	45·0	30·0	51·5	10·0
12	53·95	40·0	13 0 1·5	20·0
13	44 3·9	50·0	11·45	30·0
14	13·9	52 1·0	21·45	40·0
15	23·85	10·0	31·5	50·0
16	33·75	20·0	51·3	8 1·0
17	45 3·7	30·0	1 1·5	10·0
18	13·7	40·0	11·0	20·0
19	23·7	50·0	21·0	30·0
20	33·6	53 1·0	31·0	40·0
21	44·65	10·0	42·0	50·0
22	53·55	30·0	51·1	9 1·0
23	46 3·5	40·0	2 1·4	10·0
24	23·5	50·0	11·0	20·0
25	33·5	54 10·0	20·9	30·0
26	43·5	20·0	31·0	40·0
27	53·5	30·0	51·0	50·0
28	47 3·4	40·0	3 1·0	10 1·0
29	13·35	50·0	10·9	10·0
30	23·35	55 1·0	30·9	20·0
31	33·25	10·0	42·0	30·0
32	44·25	20·0	50·8	40·0
33	48 3·1	30·0	4 0·7	50·0
34	13·3	40·0	10·75	11 1·0
35	23·3	50·0	20·7	10·0
36	33·1	56 20·0	30·7	20·0
37	12 48 44·1	12 56 30·0	13 4 41·6	30·0
38	...	...	...	40·0
39	...	...	...	50·0
40	...	...	...	12 0·0
41	...	...	...	13 12 20·0

1875, MARCH 7 (*continued*)

Number of signal	SET 21	SET 22	SET 23	SET 24
	Time by chronometer Tiede 340	Time by chronometer Tiede 340	Time by chronometer Tiede 340	Time by chronometer Tiede 340
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	13 13 49·3	13 21 30·0	13 29 56·4	13 37 1·0
2	59·2	40·0	30 6·4	10·0
3	14 9·1	50·0	16·4	20·0
4	19·0	22 1·0	26·35	40·0
5	29·0	10·0	37·3	50·0
6	40·1	20·0	56·2	38 1·0
7	49·0	30·0	31 6·25	10·0
8	59·0	40·0	16·4	20·0
9	15 8·8	50·0	37·0	30·0
10	18·9	23 1·0	46·2	40·0
11	28·8	10·0	32 6·1	50·0
12	39·75	20·5	16·1	39 1·0
13	48·75	30·0	26·1	10·0
14	58·7	40·0	37·0	20·0
15	16 8·9	50·0	46·0	30·0
16	18·8	24 1·0	56·0	40·0
17	28·75	10·0	33 6·0	40 0·0
18	39·65	20·0	15·95	10·0
19	48·5	30·0	25·9	20·0
20	58·7	40·0	36·9	40·0
21	17 8·6	50·0	45·85	50·0
22	18·5	25 0·0	55·75	41 1·0
23	28·5	10·0	34 5·8	10·0
24	39·5	20·0	15·75	20·0
25	48·5	30·0	25·7	50·0
26	58·45	40·0	36·65	42 1·0
27	18 8·4	50·0	55·6	10·0
28	18·4	26 1·0	35 5·7	20·0
29	28·3	10·0	15·55	30·0
30	48·4	20·0	25·5	40·0
31	58·2	30·0	35·5	50·0
32	19 8·1	40·0	45·5	43 1·0
33	18·0	50·0	55·5	10·0
34	28·2	27 1·0	36 5·5	20·0
35	39·1	10·0	15·45	30·0
36	58·0	20·0	25·4	40·0
37	20 8·05	30·0	13 36 36·4	50·0
38	18·0	40·0	...	13 44 1·0
39	28·0	50·0	...	...
40	13 20 39·0	28 1·0	...	...
41	...	10·0	...	...
42	...	20·0	...	...
43	...	13 28 30·0	...	...

1875, March 10							1875, March 12			
Number of signal	Set 25			Set 26			Set 27			Set 28		
	Time by chronometer Tiede 340			Time by chronometer Tiede 340			Time by chronometer Tiede 340			Time by chronometer Tiede 340		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	15	58	43·1	16	7	30·0	16	6	34·0	16	14	20·0
2			53·3			40·0			44·1			30·0
3		59	3·1			50·0			54·0			40·0
4			13·0		8	10·0		7	4·0			50·0
5			24·0			20·0			14·0		15	1·0
6			33·1			30·0			25·0			10·0
7			43·15			40·0			34·0			20·0
8			53·0			50·0			43·8			30·0
9	16	0	3·0		9	1·0			53·9			40·0
10			13·0			20·0		8	3·85			50·0
11			24·05			30·0			13·75		16	1·0
12			33·0			40·0			23·8			10·0
13			42·9			50·0			33·75			20·0
14			52·85		10	1·0			43·7			30·0
15		1	2·9			10·0			53·7			40·0
16			12·8			20·0		9	3·6			50·0
17			23·8			30·0			13·55		17	1·0
18			32·8			40·0			24·55			10·0
19			42·7			50·0			33·5			20·0
20	16	1	52·65		11	1·0			43·5			30·0
21		...				10·0			53·55			40·0
22		...				20·0		10	3·5			50·0
23		...				30·0			13·5		18	1·0
24		...				40·0			24·4			10·0
25		...				50·0			33·4			20·0
26		...			12	1·0			43·4			30·0
27		...				10·0			53·25			40·0
28		...				20·0		11	3·3			50·0
29		...		16	12	30·0			13·35		19	1·0
30		...			...				23·25			10·0
31		...			...				33·25			20·0
32		...			...				53·2			40·0
33		...			...			12	3·15			50·0
34		...			...				13·1		16	20 1·0
35		...			...				24·15		...	
36		...			...				33·05		...	
37		...			...				43·0		...	
38		...			...				53·05		...	
39		...			...			13	3·0		...	
40		...			...				13·0		...	
41		...			...		16	13	23·9		...	

1875, MARCH 12 (*continued*)

Number of signal	SET 29	SET 30	SET 31	SET 32
	Time by chronometer Tiede 340	Time by chronometer Tiede 340	Time by chronometer Tiede 340	Time by chronometer Tiede 340
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	16 23 22·3	16 31 20·0	17 25 50·0	17 34 11·5
2	41·4	30·0	26 1·0	21·3
3	51·3	40·0	10·0	30·5
4	24 1·25	50·0	20·0	40·3
5	11·15	32 1·0	30·0	50·1
6	22·1	10·0	40·0	35 0·0
7	41·1	20·0	50·0	11·0
8	51·2	30·0	27 1·0	20·5
9	25 1·1	40·0	10·0	40·0
10	11·05	50·0	20·0	50·0
11	22·0	33 1·0	30·0	59·8
12	30·95	10·0	40·0	36 10·95
13	40·95	20·0	50·0	20·6
14	50·9	30·0	28 1·0	30·0
15	26 0·85	40·0	10·0	37 19·4
16	10·9	50·0	20·0	30·4
17	21·8	16 34 1·0	30·0	39·8
18	30·8	...	40·0	49·8
19	40·75	...	50·0	59·5
20	50·7	...	29 1·0	17 38 10·7
21	27 0·75	...	10·0	...
22	10·7	..	20·0	...
23	21·7	...	30·0	...
24	30·65	...	40·0	...
25	40·6	...	30 1·0	...
26	50·55	...	20·0	...
27	28 0·6	...	30·0	...
28	21·5	...	40·0	...
29	40·5	...	50·0	...
30	50·5	...	31 1·0	...
31	29 0·4	...	20·0	...
32	10·4	...	30·0	...
33	21·35	...	40·0	...
34	30·4	...	50·0	...
35	40·25	...	32 1·0	...
36	30 0·2	...	17 32 10·0	...
37	16 30 10·2	...	...	...

1875, March 13

Number of signal	Set 33	Set 34	Set 35	Set 36
	Time by chronometer Tiede 340	Time by chronometer Tiede 340	Time by chronometer Tiede 340	Time by chronometer Tiede 340
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	14 29 0·95	14 36 1·0	14 43 58·4	14 51 20·0
2	11·0	10·0	44 8·7	30·0
3	21·05	20·0	18·55	40·0
4	31·0	30·0	28·6	50·0
5	41·1	50·0	39·55	52 1·0
6	51·1	37 1·0	48·55	10·0
7	30 1·0	10·0	58·5	20·0
8	10·9	20·0	45 8·5	30·0
9	20·85	30·0	18·5	40·0
10	30·9	40·0	28·5	50·0
11	41·85	50·0	39·4	53 1·0
12	50·8	38 0·0	48·4	10·0
13	31 0·8	10·0	58·3	20·0
14	10·75	20·0	46 8·3	30·0
15	20·75	30·0	18·3	40·0
16	30·7	40·0	28·25	50·0
17	40·7	50·0	39·2	54 1·0
18	50·6	39 1·0	48·25	10·0
19	32 0·6	10·0	58·3	20·0
20	10·7	20·0	47 8·1	30·0
21	20·5	30·0	18·15	40·0
22	30·5	40·0	28·1	50·0
23	41·5	50·0	39·05	55 1·0
24	50·5	40 1·0	48·1	10·0
25	33 0·5	10·0	58·0	20·0
26	10·5	20·0	48 8·0	40·0
27	20·4	30·0	18·0	50·0
28	30·4	40·0	28·0	56 20·0
29	41·35	50·0	38·95	30·0
30	50·3	41 1·0	47·9	40·0
31	34 0·25	10·0	57·9	50·0
32	10·25	20·0	49 7·85	57 1·0
33	14 34 30·2	30·0	17·8	10·0
34	...	40·0	27·8	20·0
35	...	50·0	38·75	30·0
36	...	42 1·0	47·75	40·0
37	...	10·0	57·7	50·0
38	...	20·0	50 7·7	58 1·0
39	...	14 42 30·0	17·7	10·0
40	...	...	14 50 38·55	14 58 20·0

1875, March 14

Number of signal	Set 37	Set 38	Set 39	Set 40
	Time by chronometer Tiede 340	Time by chronometer Tiede 340	Time by chronometer Tiede 340	Time by chronometer Tiede 340
	h. m. s.	h. m. s.	h. m. s	h. m. s.
1	14 40 2·0	14 59 20·0	15 8 37·8	15 29 53·6
2	11·8	30·0	57·1	30 3·55
3	31·8	40·0	9 7·05	13·55
4	55 49·25	50·0	17·0	23·5
5	59·25	15 0 0·0	27·05	34·5
6	56 9·2	10·0	38·0	43·45
7	19·15	20·0	46·95	53·4
8	48·9	30·0	57·05	31 3·35
9	59·1	40·0	10 6·85	13·4
10	57 9·0	50·0	16·9	23·35
11	18·95	1 1·0	26·8	34·35
12	14 57 39·8	11·0	37·8	32 23·15
13	...	22·0	56·7	34·1
14	...	30·0	11 6·75	43·15
15	...	40·0	16·7	53·15
16	...	50·0	26·65	33 3·1
17	...	2 0·0	37·6	13·1
18	...	10·0	46·55	23·05
19	...	20·0	56·55	33·1
20	...	30·0	12 6·5	43·0
21	...	40·0	16·5	53·0
22	...	50·0	26·5	34 3·0
23	...	3 1·0	37·5	12·9
24	...	10·0	46·5	22·95
25	...	20·0	56·45	33·9
26	...	30·0	13 6·35	42·85
27	...	40·0	16·3	52·8
28	...	50·0	26·3	35 2·75
29	...	4 1·0	37·3	12·75
30	...	10·0	46·45	22·7
31	...	20·0	56·1	32·7
32	...	30·0	14 6·2	42·65
33	...	40·0	16·2	52·6
34	...	50·0	26·15	36 2·6
35	...	5 1·0	15 14 37·1	22·55
36	...	10·0	...	15 36 33·55
37	...	20·0	...	...
38	...	30·0	...	...
39	...	40·0	...	...
40	...	50·0	...	...
41	...	6 1·0	...	...
42	...	15 6 10·0	...	...

Set 41

Number of signal	Time by chronometer Tiede 340	Number of signal	Time by chronometer Tiede 340	Number of signal	Time by chronometer Tiede 340	Number of signal	Time by chronometer Tiede 340
	h. m. s.		h. m. s.		h. m. s.		h. m. s.
1	15 37 20·0	11	15 39 1·0	21	15 40 40·0	31	15 42 50·0
2	30·0	12	10·0	22	50·0	32	43 10·0
3	40·0	13	20·0	23	41 1·0	33	20·0
4	50·0	14	30·0	24	10·0	34	30·0
5	38 1·0	15	40·0	25	20·0	35	40·0
6	10·0	16	50·0	26	30·0	36	50·0
7	20·0	17	40 0·0	27	50·0	37	44 1·0
8	30·0	18	10·0	28	42 1·0	38	15 44 10·0
9	41·0	19	20·0	29	20·0		
10	15 38 50·0	20	15 40 30·0	30	15 42 40·0		

Signals sent to and received from Malta.

The following are the chronometer and local sidereal times of despatch and receipt of signals to and from Malta. The sidereal times have been taken over to the Malta end, where the longitude is deduced :—

1875, March 10

Number of signal	Set 1	Set 2	Set 3	Set 4
	Time by chronometer S	Time by chronometer S	Time by chronometer S	Time by chronometer S
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	11 22 54·5	11 37 10·0	14 18 0·0	14 32 37·3
2	23 4·7	20·0	10·0	47·2
3	14·7	30·0	20·0	57·2
4	24·6	40·0	30·0	33 7·3
5	34·75	38 1·0	50·0	17·3
6	24 4·8	20·0	19 10·0	28·45
7	14·8	30·0	20·0	37·5
8	24·8	40·0	30·0	47·5
9	34·85	50·0	40·0	57·5
10	44·9	39 0·0	50·0	34 7·55
11	54·95	10·0	20 30·0	17·55
12	25 15·0	20·0	40·0	27·6
13	35·0	30·0	50·0	37·6
14	45·1	40·0	21 10·0	47·65
15	55·0	50·0	20·0	57·7
16	26 5·1	40 0·0	30·0	35 7·65
17	15·05	10·0	40·0	17·6
18	25·15	20·0	50·0	27·7
19	35·3	30·0	22 0·0	37·75
20	45·3	40·0	10·0	47·75
21	55·4	50·0	20·0	57·75
22	27 5·4	41 0·0	30·0	36 7·8
23	15·3	20·0	40·0	17·8
24	25·35	30·0	50·0	27·85
25	35·35	40·0	23 0·0	37·85
26	45·4	50·0	10·0	47·9
27	55·45	42 0·0	20·0	58·0
28	28 5·45	10·0	30·0	37 8·0
29	15·5	20·0	40·0	18·0
30	25·5	30·0	50·0	28·05
31	35·55	40·0	24 10·0	38·1
32	45·6	50·0	20·0	48·1
33	55·65	43 1·0	30·0	58·05
34	29 5·7	10·0	40·0	38 18·15
35	15·65	20·0	50·0	28·2
36	25·7	30·0	25 0·0	38·3
37	35·75	40·0	10·0	48·45
38	45·85	50·0	20·0	58·4
39	55·85	44 0·0	30·0	39 8·4
40	30 5·9	10·0	40·0	18·3
41	15·85	20·0	50·0	29·5
42	25·9	30·0	26 1·0	38·45
43	35·9	40·0	10·0	48·45
44	45·9	50·0	20·0	58·5
45	55·95	45 0·0	30·0	40 8·4
46	31 6·0	10·0	40·0	18·5
47	16·0	20·0	50·0	28·6
48	46·1	40·0	27 0·0	38·6
49	56·1	50·0	10·0	48·7
50	32 6·2	46 1·0	20·0	58·6
51	16·1	10·0	30·0	41 8·7
52	26·1	20·0	40·0	18·7
53	36·3	30·0	50·0	28·75
54	11 32 46·4	40·0	14 28 0·0	38·75
55	...	50·0	...	48·8
56	...	11 47 0·0	...	58·8
57	...	...	...	42 8·8
58	...	...	...	18·95
59	...	...	...	29·0
60	...	...	...	14 42 39·0

1875, March 11							1875, March 12					
Number of signal	Set 5			Set 6			Set 7			Set 8 : Morse		
	Time by chronometer S			Time by chronometer S			Time by chronometer S			Time by chronometer S		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1	10	49	21·8	11	1	10·0	10	59	30·0	11	15	16·0
2			31·7			20·0			40·0			25·9
3			41·7			30·0			50·0			35·9
4			51·7			40·0	11	0	0·0			45·95
5		50	2·8			50·0			10·0			56·0
6			11·9		2	0·0			20·0		16	6·05
7			21·8			10·0			30·0			17·1
8			31·9			20·0			40·0			26·1
9			42·0			40·0			50·0			36·15
10			52·0			50·0		1	1·0		20	56·85
11		51	1·9		3	1·0.			10·0		21	6·9
12			12·0			10·0			20·0			16·95
13			22·0			20·0			30·0			26·95
14			32·0			30·0			40·0			37·0
15			42·0			40·0			50·0			47·0
16			52·1			50·0		2	0·0			57·0
17		52	2·15		4	0·0			20·0		22	7·1
18			12·1			20·0			30·0			18·15
19			22·2			30·0			40·0			27·1
20			32·3			40·0			50·0			37·05
21			42·2			50·0		3	0·0			47·2
22			52·25		5	0·0			10·0			57·15
23		53	22 4			10·0			20·0		24	17·4
24			32 4			20·0			30·0			27·45
25			42·4			30·0			50·0			37·5
26			52·4			40·0		4	0·0			47·5
27		54	3·5			50·0			10·0			57·55
28			12·5		6	1·0			20·0		25	7·6
29			22·5			10·0			40·0			17·65
30			32·5			20·0			50·0		33	8·95
31			42·5			30·0		5	0·0			19·0
32			52·6			40·0			9·0			28·95
33		55	2·7			50·0			20·0			39·0
34			12·65		7	0·0			30·0			49·05
35			22·7			30·0			40·0			59·05
36			32·75			40·0			50·0	11	34	9·1
37			52·75			50·0		6	0·0		...	
38		56	2·8		8	0·0			10·0		...	
39			12·85			10·0			20·0		...	
40			22·85			20·0			30·0		...	
41			32·9			30·0			40·0		...	
42			42·9			40·0			50·0		...	
43			52·9			50·0		7	0·0		...	
44		57	3·0		9	1·0			10·0		...	
45			23·0			20·0			20·0		...	
46			33·0			30·0			30·0		...	
47			43·05			50·0			40·0		...	
48			53·0		10	0·0			50·0		...	
49		58	4·2			10·0		8	1·0		...	
50			13·05			20·0			20·0		...	
51			23·15			30·0			30·0		...	
52			33·2			40·0			40·0		...	
53			43·2			50·0		9	0·0		...	
54	10	59	3·35	11	11	0·0			10·0		...	
55		...			...				20·0		...	
56		...			...		11	9	30·0		...	

1875, MARCH 12 (*continued*)

Number of signal	SET 9	SET 10	SET 11 : Morse	SET 12
	Time by chronometer S	Time by chronometer S	Time by chronometer S	Time by chronometer S
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	11 17 46·3	14 5 4·5	14 9 35·4	14 27 0·0
2	56·25	14·6	45·45	10·0
3	18 6·3	34·7	55·4	20·0
4	26·4	44·7	10 5·45	30·0
5	36·45	6 4·8	15·45	40·0
6	46·5	45·85	25·5	50·0
7	56·5	54·8	35·6	28 1·0
8	19 6·5	7 4·85	46·55	10·0
9	16·5	14·8	55·55	20·0
10	26·5	24·95	11 5·65	30·0
11	36·55	34·9	15·65	40·0
12	46·7	44·95	25·65	50·0
13	56·7	55·0	12 45·9	29 10·0
14	20 6·8	8 5·1	55·9	20·0
15	27 27·9	15·05	13 5·95	30·0
16	37·85	25·1	16·0	40·0
17	48·0	35·1	26·0	30 0·0
18	57·95	45·1	36·1	20·0
19	28 7·95	55·2	56·1	30·0
20	18·05	15 46·4	14 6·15	40·0
21	28·1	56·45	21 27·4	50·0
22	48·2	16 6·4	37·4	31 0·0
23	30 18·5	16·5	47·55	10·0
24	28·5	26·5	57·5	20·0
25	38·5	36·5	22 7·45	30·0
26	48·5	46·55	17·5	40·0
27	58·5	56·6	27·55	50·0
28	31 8·6	17 6·6	37·55	32 10·0
29	18·6	18 56·85	47·65	20·0
30	28·65	19 7·0	57·6	30·0
31	34 39·2	16·95	24 27·85	40·0
32	49·2	27·0	37·95	50·0
33	59·25	37·1	49·0	33 0·0
34	35 9·25	47·1	58·0	10·0
35	11 35 19·3	57·1	14 25 8·05	20·0
36	...	14 20 7·2	...	30·0
37	...	...	...	40·0
38	...	...	...	50·0
39	...	...	...	34 0·0
40	...	...	...	10·0
41	...	...	...	20·0
42	...	...	...	30·0
43	...	...	...	40·0
44	...	...	...	50·0
45	...	...	...	35 0·0
46	...	...	...	10·0
47	...	...	...	20·0
48	...	...	...	30·0
49	...	...	...	40·0
50	...	...	...	50·0
51	...	...	...	36 1·0
52	...	...	...	10·0
53	...	...	...	20·0
54	...	...	...	30·0
55	...	...	...	40·0
56	...	...	...	50·0
57	...	...	...	14 37 0·0

1875, MARCH 14

Number of signal	SET 13	SET 14	SET 15	SET 16
	Time by chronometer S	Time by chronometer S	Time by chronometer S	Time by chronometer S
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	7 35 30·0	7 52 19·9	7 55 50·4	10 11 42·0
2	40·0	29·8	56 0·45	52·0
3	50·0	39·95	10·4	12 2·05
4	36 0·0	51·0	20·4	12·05
5	10·0	53 1·05	30·45	32·1
6	20·0	10·0	40·5	42·2
7	30·0	20·05	50·5	52·1
8	40·0	30·05	57 0·6	13 2·2
9	50·0	40·1	10·55	20 33·4
10	37 1·0	50·15	20·6	43·3
11	20·0	8 2 21·4	30·65	53·4
12	30·0	41·5	59 0·85	21 3·45
13	40·0	51·55	10·9	13·5
14	50·0	3 1·5	20·95	23·45
15	38 0·0	11·5	30·95	33·5
16	10·0	21·55	41·0	43·5
17	20·0	31·7	52·0	53·55
18	30·0	41·6	8 0 1·0	22 3·6
19	40·0	51·65	11·05	13·6
20	50·0	5 31·85	21·05	23·6
21	39 10·0	41·95	31·0	24 3·9
22	30·0	53·0	41·1	13·95
23	40·0	6 12·0	51·15	23·95
24	50·0	22·05	9 2·4	33·95
25	40 1·0	32·1	12·4	44·0
26	10·0	42·05	22·45	54·0
27	20·0	52·1	32·5	25 4·0
28	30·0	11 32·9	42·5	14·1
29	40·0	42·9	52·6	24·05
30	50·0	53·9	10 2·55	34·1
31	41 0·0	12 2·95	12·6	44·15
32	10·0	12·95	8 10 22·7	54·2
33	20·0	8 12 23·0	...	26 15·3
34	30·0	...	...	31 25·0
35	40·0	...	...	35·1
36	50·0	...	...	10 31 45·2
37	42 0·0	...	...	...
38	10·0	...	...	...
39	20·0	...	...	...
40	40·0	...	...	...
41	50·0	...	...	...
42	43 0·0	...	...	...
43	10·0	...	...	...
44	20·0	...	...	...
45	30·0	...	...	...
46	40·0	...	...	...
47	50·0	...	...	...
48	44 1·0	...	...	...
49	10·0	...	...	...
50	20·0	...	...	...
51	30·0	...	...	...
52	40·0	...	...	...
53	50·0	...	...	...
54	45 0·0	...	...	...
55	10·0	...	...	...
56	20·0	...	...	...
57	7 45 30·0	...	...	...

1875, March 14 (*continued*)			1875, March 15	
Number of signal	Set 17	Set 18	Set 19	Set 20
	Time by chronometer S	Time by chronometer S	Time by chronometer S	Time by chronometer S
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	10 14 13·2	10 51 40·0	7 40 48·0	7 43 58·7
2	32·4	50·0	58·2	44 8·75
3	42·5	52 0·0	41 8·25	18·8
4	52·4	10·0	18·3	28·7
5	15 12·5	20·0	28·2	38·75
6	22·5	30·0	38·25	48·8
7	32·55	40·0	49·4	58·8
8	52·6	50·0	42 8·3	45 8·8
9	16 2·6	53 1·0	18·35	18·85
10	12·65	10·0	28·3	28·9
11	17 42·85	20·0	38·45	38·85
12	52·8	30·0	48·5	48·95
13	18 3·85	40·0	58·5	58·95
14	12·9	50·0	43 8·55	46 9·0
15	23·0	54 0·0	18·55	19·05
16	33·0	10·0	28·6	29·1
17	43·1	20·0	7 43 38·6	39·1
18	53·05	30·0	...	50·15
19	19 3·1	40·0	...	59·15
20	13·15	50·0	...	47 19·2
21	27 24·4	55 0·0	...	29·2
22	34·5	10·0	...	39·25
23	28 4·5	20·0	...	7 47 49·3
24	14·7	30·0	...	...
25	34·65	40·0	...	...
26	44·6	50·0	...	...
27	10 28 54·6	56 0·0	...	...
28	...	10·0	...	...
29	...	20·0	...	...
30	...	30·0	...	...
31	...	40·0	...	...
32	...	50·0	...	...
33	...	57 0·0	...	...
34	...	10·0	...	...
35	...	20·0	...	...
36	...	30·0	...	...
37	...	40·0	...	...
38	...	50·0	...	...
39	...	58 1·0	...	...
40	...	10·0	...	...
41	...	20·0	...	...
42	...	30·0	...	...
43	...	40·0	...	...
44	...	50·0	...	...
45	...	59 0·0	...	...
46	...	10·0	...	...
47	...	20·0	...	...
48	...	30·0	...	...
49	...	40·0	...	...
50	...	50·0	...	...
51	...	11 0 0·0	...	...
52	...	10·0	...	...
53	...	20·0	...	...
54	...	30·0	...	...
55	...	40·0	...	...
56	...	50·0	...	...
57	...	1 1·0	...	...
58	...	10·0	...	...
59	...	20·0	...	...
60	...	30·0	...	...
61	...	11 1 40·0	...	...

1875, MARCH 15 (*continued*)

Number of signal	SET 21	SET 22	SET 23	SET 24
	Time by chronometer S	Time by chronometer S	Time by chronometer S	Time by chronometer S
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	7 49 0·0	7 57 11·0	7 59 31·3	8 5 0·0
2	10·0	20·95	41·3	10·0
3	20·0	31·0	51·3	20·0
4	30·0	41·0	8 0 1·4	40·0
5	50·0	51·05	11·4	50·0
6	51 10·0	58 1·1	21·5	6 1·0
7	20·0	21·1	31·5	10·0
8	30·0	31·15	41·5	20·0
9	40·0	41·2	51·55	30·0
10	50·0	51·2	1 1·55	40·0
11	52 0·0	7 59 1·25	11·6	8 20·0
12	10·0	...	21·6	30·0
13	20·0	...	31·65	40·0
14	30·0	...	41·6	11 30·0
15	40·0	...	51·7	40·0
16	50·0	...	2 1·75	50·0
17	53 0·0	...	11·75	8 12 0·0
18	10·0	...	21·8	...
19	20·0	...	31·85	...
20	30·0	...	41·85	...
21	40·0	...	52·9	...
22	50·0	...	3 1·95	...
23	54 0·0	...	11·95	...
24	10·0	...	22·0	...
25	20·0	...	32·0	...
26	30·0	...	42·0	...
27	40·0	...	52·05	...
28	50·0	...	8 4 2·1	...
29	55 1·0	...	...	...
30	10·0	...	...	...
31	20·0	...	...	...
32	30·0	...	...	...
33	40·0	...	...	...
34	50·0	...	...	...
35	7 56 0·0	...	...	...

1875, MARCH 15 (*continued*)

Number of signal	SET 25	SET 26	SET 27	SET 28
	Time by chronometer S	Time by chronometer S	Time by chronometer S	Time by chronometer S
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	8 23 0·0	8 30 56·5	8 34 7·3	8 42 0·0
2	10·0	31 6·7	17·4	10·0
3	20·0	16·9	27·4	20·0
4	30·0	26·85	37·4	30·0
5	40·0	36·9	47·4	40·0
6	50·0	46·9	57·5	50·0
7	24 1·0	58·0	35 7·5	43 0·0
8	10·0	32 7·0	17·5	10·0
9	20·0	17·0	27·5	20·0
10	30·0	27·0	37·55	30·0
11	40·0	37·0	47·55	40·0
12	50·0	47·0	57·6	50·0
13	25 1·0	57·05	36 7·6	44 1·0
14	10·0	33 7·15	17·7	10·0
15	20·0	17·15	27·75	20·0
16	30·0	27·2	37·75	30·0
17	40·0	37·25	47·75	40·0
18	50·0	8 33 47·25	58·8	50·0
19	26 0·0	...	37 7·8	45 0·0
20	10·0	...	17·85	10·0
21	19·0	...	28·0	20·0
22	30·0	...	37·95	30·0
23	40·0	...	47·9	40·0
24	50·0	...	8 37 58·0	50·0
25	27 0·0	...	...	46 0·0
26	10·0	...	...	10·0
27	20·0	...	...	20·0
28	30·0	...	...	30·0
29	40·0	...	...	40·0
30	50·0	...	...	50·0
31	28 0·0	...	...	47 0·0
32	10·0	...	...	10·0
33	20·0	...	...	20·0
34	30·0	...	...	30·0
35	40·0	...	...	40·0
36	50·0	...	...	50·0
37	29 0·0	...	...	48 1·0
38	10·0	...	...	10·0
39	20·0	...	...	20·0
40	30·0	...	...	30·0
41	40·0	...	...	40·0
42	50·0	...	...	50·0
43	8 30 0·0	...	...	8 49 0·0

1875, MARCH 15 (*continued*)

Number of signal	SET 29	SET 30	SET 31	SET 32
	Time by chronometer S	Time by chronometer S	Time by chronometer S	Time by chronometer S
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	8 49 59·95	8 54 40·8	9 17 54·8	9 21 55·4
2	50 20·1	50·9	18 4·85	22 5·45
3	30·15	55 0·9	14·9	15·45
4	40·15	10·95	24·8	25·5
5	51 0·25	21·00	34·9	35·5
6	10·3	30·95	44·9	45·5
7	20·25	40·9	54·95	55·5
8	30·25	50·95	19 5·0	23 5·55
9	40·3	56 1·0	14·95	15·55
10	50·3	11·0	25·0	25·6
11	52 0·35	21·0	35·0	35·65
12	10·5	31·05	45·0	45·6
13	20·3	41·05	55·0	24 5·8
14	30·4	51·15	20 5·05	15·8
15	40·45	8 57 2·2	15·05	25·8
16	50·5	...	25·1	9 24 35·8
17	53 0·5	...	35·15	...
18	10·55	...	45·15	...
19	20·5	...	55·2	...
20	30·55	...	21 6·2	...
21	40·6	...	15·25	...
22	50·6	...	25 25	...
23	54 0·75	...	9 21 35·3	...
24	8 54 10·75	...	...	...

SET 33

Number of signal	Time by chronometer S	Number of signal	Time by chronometer S	Number of signal	Time by chronometer S	Number of signal	Time by chronometer S
	h. m. s.		h. m. s.		h. m. s.		h. m. s.
1	9 32 30·0	12	9 34 30·0	23	9 36 20·0	34	9 38 10·0
2	40·0	13	40·0	24	30·0	35	20·0
3	50·0	14	50·0	25	40·0	36	30·0
4	33 0·0	15	35 1·0	26	50·0	37	40·0
5	10·0	16	10·0	27	37 0·0	38	50·0
6	30·0	17	20·0	28	10·0	39	39 0·0
7	40·0	18	30·0	29	20·0	40	10·0
8	50·0	19	40·0	30	30·0	41	20·0
9	34 0·0	20	50·0	31	40·0	42	9 39 30·0
10	10·0	21	36 1·0	32	50·0		
11	9 34 20·0	22	9 36 10·0	33	9 38 0·0		

The following signals, which form a part of the materials for the finally adopted longitude of Alexandria, were exchanged between Malta and Berlin. For the corresponding local

sidereal times see pp. 386 *et seq.* in the chapter on the operations at Malta, in which also the resulting difference of longitude will be found. It will be noticed, however, that the time could not be determined at Malta on March 13; therefore the signals recorded there on that day are of no use, except as affording the sum of the longitudes Berlin-Malta and Malta-Alexandria, it being obviously unadvisable to rely upon the rate of a single chronometer for intervals longer than a few hours.

1875, March 13

Number of signal	Set 12*a*	Set 12*b*	Set 12*c*	Set 12*d*	Set 12*e*	Set 12*f*
	Time by chronometer S	Time by chronometer S	Time by chronometer S	Time by chronometer S	Time by chronometer S	Time by chronometer S
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1	12 52 54·7	12 56 35·45	13 47 23·8	13 49 34·4	13 15 40·0	13 29 10·0
2	53 4·8	45·5	33·9	44·3	50·0	20·0
3	14·75	55·4	44·0	54·4	16 10·0	30·0
4	24·8	57 5·45	55·0	50 4·4	20·0	40·0
5	34·8	15·4	48 4·1	14·45	30·0	30 0·0
6	44·9	25·5	14·15	24·5	40·0	10·0
7	54·95	35·5	24·1	34·55	50·0	20·0
8	54 4·95	45·55	34·2	44·5	17 1·0	30·0
9	14·95	55·5	52 44·9	54·6	10·0	40·0
10	25·0	58 5·6	55·9	51 4·6	30·0	50·0
11	45·05	15·6	53 4·95	14·7	40·0	31 1·0
12	55·1	25·6	15·0	55 55·4	50·0	10·0
13	55 15·2	59 35·85	24·95	56 5·35	18 0·0	30·0
14	13 2 26·4	45·95	35·05	15·5	10·0	40·0
15	36·45	55·9	45·05	25·45	20·0	50·0
16	46·5	13 0 5·9	55·05	45·55	30·0	32 0·0
17	56·5	16·0	54 5·1	56·55	40·0	10·0
18	3 6·5	26·0	13 54 15·15	57 5·55	50·0	20·0
19	16·5	36·05	...	13 57 15·6	19 1·0	30·0
20	26·55	46·1	...	...	20·0	40·0
21	36·55	1 6·1	...	...	30·0	50·0
22	46·7	13 1 16·15	...	...	40·0	33 0·0
23	56·65	...	...	...	50·0	10·0
24	4 47·8	...	...	...	20 0·0	20·0
25	5 37·0	...	...	...	10·0	30·0
26	47·05	...	...	...	20·0	40·0
27	56·95	...	...	...	30·0	50·0
28	6 7·0	...	...	...	40·0	34 10·0
29	17·0	...	...	...	50·0	20·0
30	27·05	...	...	...	21 0·0	30·0
31	37·1	...	...	...	10·0	40·0
32	47·15	...	...	...	20·0	50·0
33	8 17·4	...	...	...	30·0	35 10·0
34	27·35	...	...	...	40·0	40·0
35	37·35	...	...	...	50·0	50·0
36	47·5	...	...	...	22 0·0	36 0·0
37	57·4	...	...	...	10·0	10·0
38	9 7·5	...	...	...	20·0	20·0
39	17·5	...	...	...	30·0	30·0
40	27·5	...	...	...	50·0	40·0
41	37·55	...	...	...	23 0·0	50·0
42	47·6	...	...	...	10·0	37 10·0
43	57·65	...	...	...	20·0	20·0
44	10 7·7	...	...	...	30·0	30·0
45	48·8	...	...	...	40·0	40·0
46	11 47·95	...	...	...	50·0	50·0
47	58·0	...	...	...	24 0·0	38 10·0
48	12 8·0	...	...	...	10·0	20·0
49	17·95	...	...	...	20·0	30·0
50	28·0	...	...	...	30·0	40·0
51	38·1	...	...	...	40·0	50·0
52	13 12 48·15	...	...	...	50·0	13 39 0·0
53	...	...	...	...	25 1·0	...
54	...	...	...	...	10·0	...
55	...	...	...	...	13 25 20·0	...

Personal Equation between Dr. Becker and Dr. Löw in determining the Time.

1875, April 15.

Comparisons of Tiede 340 *with Tiede* 3, *the Transit Clock, by coincident Beats.*

	Dr. Becker			Dr. Löw			Dr. Becker		
	h.	m.	s.	h.	m.	s.	h.	m.	s.
Tiede 3 . .	11	56	1·0	11	58	43·0	12	1	36·0	12	41	47·0	14	13	4·0
Tiede 340 . .	10	19	14·0	10	21	55·5	10	24	48·0	11	4	52·5	12	35	54·5

The following observations were taken with the Berlin transit circle, Arm W. :—

Observer, Dr. Becker, using Tiede 3 and the Chronograph, except for *a* Ursæ Min., which was observed by eye and ear.

Name of star	Seconds of transit over the wires														
	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.
	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
6 Canum ven.	19·70	24·80	29·90	40·08	45·25	50·65	0·70	6·02	10·90	21·00	26·10	31·35	41·37	46·47	51·67
20 Comæ	12·17	16·55	20·87	29·13	33·35	37·57	46·02	50·23	54·40	2·90	7·03	11·25	19·70	24·00	28·25
24 Comæ	38·02	42·25	46·35	54·70	58·95	3·00	11·25	15·35	19·57	27·90	31·95	36·05	44·25	48·50	52·60
a Ursæ min. S.P.	...	...	...	50·9	0·1	15·1	46·1	58·1	11·2	43·1	55·9	8·0	38·3	52·0	...
τ Boötis	5·95	10·03	14·25	22·40	26·60	30·85	39·02	43·23	47·36	55·40	59·75	3·85	12·00	16·05	20·25
η Boötis	30·20	34·55	38·75	46·88	51·12	55·27	3·70	7·65	12·00	20·15	24·36	28·60	36·68	40·99	45·20

Observations with Dr. Löw's Transit Instrument. Observer, Dr. Löw; Chronometer Tiede 340.

Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of star passing over wire VI.			Level readings	
		I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.					
		s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
6 Canum ven.	W	30·8	46·3	57·1	...	7·1	17·8	28·1	...	38·2	49·0	4·4	10	42	17·66	−19·7 +12·7	−46·3 +39·3
20 Comæ	„	23·5	36·7	...	49·6	...	2·2	...	15·2	...	28·2	41·3	10	46	2·41	+13·7 −19·6	+40·3 −46·2
a Ursæ min. S.P.	„	...	...	...	...	...	5·0	32·0	39·0	50·5	11·5	...	11	35	7·54	...	...
„ „	E	...	...	...	...	...	...	22·0	1·8	59·5	...	...		36	40·55	−19·2 +13·7	−46·1 +40·6
ζ Virginis	„	19·8	7·4	...	55·2	...	43·3	...	31·4	...	19·2	7·1	11	50	43·32	+13·3 −19·2	+40·2 −46·2
τ Boötis	„	18·2	5·7	...	53·2	...	40·1	...	...	...	...	...	12	3	40·28	...	...
η Boötis	„	41·8	29·2	...	16·3	...	3·7	...	51·2	...	...	25·2	12	11	3·63	−19·1 +13·2	−46·1 +40·4
d Boötis	„	39·0	25·4	...	12·1	...	58·9	...	45·4	...	32·0	18·6	12	26	58·75	...	...
a Boötis	W	38·0	50·1	...	3·5	...	16·2	...	28·9	...	41·8	54·5	12	32	16·17	−20·1 +13·2	−47·3 +40·2

1875, April 20.

Comparisons of Tiede 340 *with Tiede* 3, *the Transit Clock, by coincident Beats.*

	Dr. Becker											
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
Tiede 3 . .	12	14	54·0	12	35	59·0	12	39	7·0	14	3	52·0	14	6	50·0
Tiede 340 . .	10	18	6·0	10	39	7·5	10	42	15·0	12	6	46·0	12	9	43·5

OBSERVATIONS WITH THE BERLIN TRANSIT CIRCLE, ARM W. OBSERVER, DR. BECKER, USING TIEDE 3 AND CHRONOGRAPH FOR *TIME* STARS.

Name of star	Seconds of transit over the wires														
	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.
	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
6 Canum ven.	17·07	22·17	27·40	37·40	42·80	47·85	57·88	3·00	8·00	18·30	23·40	28·45	38·55	43 85	48·98
20 Comæ	9·43	13·80	17·95	26·38	30·63	34·90	43·20	47·47	51·70	0·20	4·30	8·60	17·10	21·25	25·50
24 Comæ	35·13	39·35	43·65	51·85	56·10	0·15	8·47	12·65	16·88	25·05	29·23	33·37	41·65	45·83	49·90
δ Virginis	370	7·65	11·60	19·60	23·55	27·50	35·35	39·35	43·30	51·10	55·00	59·00	6·70	10·67	14·70
α Ursæ min. S.P.	...	...	...	44·4	55·8	12·0	40·9	54·8	10·0	40·25	53·3	6·0	35·2	...	...
ζ Virginis	5·00	8·85	12·65	20·50	24·40	28·46	36·25	40·23	44·15	51·90	55·80	0·00	7·70	11·67	15·60
τ Boötis	3·35	7·43	11·55	19·82	24·00	28·10	36·35	40·40	44·60	52·80	56·85	1·02	9·25	13·37	17·65
η Boötis	27·70	31·90	36·00	44·30	48·50	52·65	1·00	5·13	9·25	17·55	21·60	25·77	34·15	38·25	42·45
τ Virginis	2·60	6·60	10·50	18·27	22·30	26·25	34·02	38·05	42·02	49·85	53·60	57·65	5·40	9·35	13·30

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, DR. LÖW; CHRONOMETER TIEDE 340.

Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of star passing wire VI.			Level readings	
		I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.					
		s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
6 Canum ven.	W	30·2	...	56·0	...	6·4	16·9	27·2	...	37·8	48·1	4·0	10	22	16·92	+16·5	+40·4
																−19·6	−43·7
20 Comæ	„	..	35·8	44·4	...	53·2	1·5	10·2	...	19·1	27·5	40·6	10	26	1·69	−19·7	−43·4
																+16·0	+40·1
24 Comæ	„	47·9	0·6	...	13·3	...	26·1	...	38·5	...	51·7	4·1	10	31	26·05	...	...
δ Virginis	„	13·7	25·9	...	38·0	...	50·1	...	2·0	...	14·3	26·2	10	51	50·05	...	...
																−18·4	−42·6
																+15·9	+40·1
α Ursæ min. S.P.	„	...	...	...	...	...	...	34·5	48·0	56·5	17·0	...	11	15	13·72	+16·0	+40·2
																−18·9	−43·1
																+16·7	+40·9
„ „	E	...	...	...	...	...	51·0	32·0	14·0	7·5	...	...		16	50·84	−18·2	−42·4
																−18·3	−42·8
ζ Virginis	„	18·5	6·3	...	54·5	...	42·4	...	30·6	...	18·1	6·0	11	30	42·32	+16·1	+40·6
τ Boötis	„	17·4	[4·2*]	...	52·3	...	39·4	...	27·2	...	14·3	1·4	11	43	39·53	[+16·2†	+46·7]
																[−18·7	−43·1]
η Boötis	„	41·1	28·2	...	15·5	...	3·1	...	50·25	...	37·4	24·4	11	51	2·83	...	...
τ Virginis	„	12·0	59·7	...	47·6	...	35·7	...	23·2	...	11·5	59·4	11	57‡	35·56	−18·9	−43·3
																+15·9	+40·3

[*] Discordant; rejected. [†] Readings discordant; rejected. ‡ 49m in original.

1875, APRIL 21.

Comparison of Tiede 340 with Tiede 3, the Transit Clock, by coincident Beats.

	Dr. Becker											
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
Tiede 3 . .	12	28	8·0	12	40	5·0	14	18	36·0	14	21	37·0
Tiede 340 . .	10	27	18·5	10	39	13·5	12	17	28·0	12	20	28·5

OBSERVATIONS WITH THE BERLIN TRANSIT CIRCLE, ARM W. OBSERVER, DR. BECKER, USING TIEDE 3 AND CHRONOGRAPH FOR *TIME* STARS.

Name of star	Seconds of transit over the wires														
	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII
	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
δ Virginis	3·20	7·20	11·10	18·90	22·95	26·90	34·70	38·70	42·65	50·45	54·38	58·37	6·20	10·15	14·10
ε Virginis	41·45	45·65	49·63	57·60	1·65	5·60	13·60	17·70	21·60	29·65	33·65	37·67	45·60	49·65	53·70
α Ursæ min. S.P.	...	...	...	45·3	57·0	10·9	40·1	55·1	6·3	38·4	53·5	...	...	...	...
ζ Virginis	4·35	8·25	12·25	20·10	24·00	28·03	35·85	39·80	43·70	51·53	55·50	59·38	7·17	11·12	15·10
τ Boötis	2·70	6·80	11·05	19·20	23·45	27·55	35·85	39·97	44·05	52·30	56·40	0·55	8·70	12·85	17·13
η Boötis	27·05	31·35	35·47	43·85	48·10	52·25	0·45	4·60	8·70	17·00	21·03	25·27	33·55	37·75	41·93
τ Virginis	2·15	6·03	10·00	17·75	21·70	25·65	33·60	37·40	41·25	49·25	53·10	57·18	4·93	8·90	12·85

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, DR. LÖW; CHRONOMETER TIEDE 340.

Name of star	Position of circle	Seconds of transit over the wires											Concluded chronometer time of transit over wire VI.			Level readings	
		I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.					
		s.	s.	s.	s.		s.		s.		s.	s.	h.	m.	s.	p.	p.
δ Virginis	E	23·6	11·7	...	...	...	47·5	...	35·6	...	23·3	11·4	10	47	47·50	+16·7 −18·2	+41·1 −42·7
ε Virginis	„	1·6	49·2	...	37·2	...	25·1	...	13·0	...	0·2	48·3	10	54	24·92	...	...
α Ursæ min. S.P.	„	...	...	32·5	23·0	...	52·5	...	...	...	...	...	11	12	51·85	−17·7 +17·2 +17·2 −17·8	−42·6 +42·2 +42·1 −43·0
„ „	W	47·0	...	33·0	42·5	...	...	...	...	...	...	...	11	11	14·81	+15·6 −18·1	+41·1 −43·8
ζ Virginis	„	...	...	...	32·7	...	44·6	...	56·9	...	8·9	21·0	11	26	44·80	...	...
τ Boötis	„	3·8	16·2	...	29·2	...	42·0	...	54·2	...	7·1	19·5	11	39	41·72	−18·5 +16·9	−44·1 +42·7
η Boötis	„	27·1	39·2	...	52·3	...	5·2	...	17·7	...	30·3	43·2	11	47	5·02	...	...
τ Virginis	E	11·6	59·5	...	47·0	...	35·3	...	23·5	...	11·2	...	11	53	35·29	−17·3 * +16·8	−42·1 +42·7

* One part wrong; rejected.

Reduction of the preceding Observations.

The transit-circle observations were reduced at the Berlin Observatory, to which institution we are indebted for the details given.

The observations with Dr. Löw's transit instrument have been reduced exactly as before.

1875, APRIL 15.

WITH THE BERLIN TRANSIT CIRCLE.

Level			Collimation, including daily aberration	Azimuth
h.	m.	s.		
At 12	15 sid. time	−0·448		
At 13	50 „	−0·423	+0ˢ·103	−0ˢ·015

WITH THE BERLIN TRANSIT CIRCLE (*continued*).

Epoch by Tiede 3	Name of star	Seconds of concluded clock time of transit over wire XI.	Sum of instrumental corrections	Seconds of star's R.A.	Clock correction
h. m.		s.	s.	s.	s.
12 55·9	6 Canum ven.	5·76	−0·44	43·82	+38·50
	20 Comæ	50·25	−0·31	28·49	38·55
	24 Comæ	15·40	−0·29	53·56	38·45
	a Ursæ min. S.P.	58·22	...	...	...
	τ Boötis	43·16	−0·27	21·37	38·48
	η Boötis	7·76	−0·27	46·00	38·51

WITH DR. LÖW'S TRANSIT INSTRUMENT.

Levellings

E	W			Collimation, circle W	Azimuth
p.	p.				
−2·75	−3·50	Mean level	$-3^{p}\cdot10$		
−2·98	−2·95	E	$-2^{p}\cdot95 = -0^{s}\cdot327$		
−2·90	−3·50	W	$-3^{p}\cdot25 = -0^{s}\cdot361$	$-1^{s}\cdot091$	$-4^{s}\cdot488$

Epoch by chronometer and assumed *hourly* chronometer rate	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Chronometer rate to epoch	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
h. m. s.			h. m. s.	s.	s.	h. m. s.	h. m. s.
11 47 0·00	6 Canum ven.	W	10 42 17·66	−10·82	− 3·17	12 19 43·84	+1 37 40·17
+10·033	20 Comæ	„	10 46 2·41	−10·19	− 3·98	12 23 28·50	40·26
	a Ursæ min. S.P.	„	11 35 7·54	− 1·99	−60·97	1 11 44·64	[40·06]
	„ „	E	36 40·55	− 1·73	−94·25	„	
	ζ Virginis	„	11 50 43·32	+ 0·62	− 2·67	13 28 21·28	40·01
	τ Boötis	„	12 3 40·28	+ 2·79	− 1·80	13 41 21·38	40·11
	η Boötis	„	12 11 3·63	+ 4·02	− 1·76	13 48 46·01	40·12
	d Boötis	„	12 26 58·75	+ 6·69	− 1·36	14 4 43·98	39·90
	a Boötis	W	12 32 16·17	+ 7·57	− 4·06	14 9 59·61	39·93

1875, APRIL 20.

WITH THE BERLIN TRANSIT CIRCLE.

Level

h. m.	s.	Collimation, including daily aberration	Azimuth
At 12 15 sid. time	−0·500		
At 14 0 „	−0·478	$+0^{s}\cdot103$	$-0^{s}\cdot026$

Epoch by Tiede 3	Name of star	Seconds of concluded clock time of transit over wire XI	Sum of instrumental corrections	Seconds of star's R.A.	Clock correction
h. m.		s.	s.	s.	s.
13 6·2	6 Canum ven.	3·03	−0·51	43·80	+41·26
	20 Comæ	47·52	−0·36	28·48	41·32
	24 Comæ	12·64	−0·35	53·55	41·26
	δ Virginis	39·27	−0·25	20·27	41·25
	a Ursæ min. S.P.	54·78	...	...	...
	ζ Virginis	40·23	−0·22	21·30	41·29
	τ Boötis	40·46	−0·33	21·41	41·28
	η Boötis	5·10	−0·33	46·04	41·27
	τ Virginis	38·01	−0·23	19·01	41·23

WITH DR. LÖW'S TRANSIT INSTRUMENT.

Levellings E p.	Levellings W p.		Collimation, circle W	Azimuth
−1·50	−1·60			
−0·75	−1·75	Mean level −1ᵖ·31		
−1·10	−1·25	E −1ᵖ·16 = −0ˢ·129		
	−1·45	W −1ᵖ·46 = −0ˢ·162	−1ˢ·140	−4ˢ·545

Epoch by chronometer and assumed *hourly* chronometer rate	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Chronometer rate to epoch	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
h. m. s.			h. m. s.	s.	s.	h. m. s.	h. m. s.
11 9 0·00	6 Canum ven.	W	10 22 16·92	−7·81	− 3·00	12 19 43·82	+1 57 37·71
+ 10·033	20 Comæ	„	10 26 1·69	−7·19	− 3·89	12 23 28·49	37·88
	24 Comæ	„	10 31 26·05	−6·28	− 4·00	12 28 53·56	37·79
	δ Virginis	„	10 51 50·05	−2·88	− 6·36	12 49 20·28	37·77
	α Ursæ min. S.P.	„	11 15 13·72	+1·04	− 66·92	1 11 45·63	
	„ „	E	16 50·84	+1·31	−164·31	„	[37·79]
	ζ Virginis	„	11 30 42·32	+3·63	− 2·44	13 28 21·31	37·90
	τ Boötis	„	11 43 39·53	+5·79	− 1·61	13 41 21·42	37·71
	η Boötis	„	11 51 2·83	+7·03	− 1·55	13 48 46·05	37·74
	τ Virginis	„	11 57 35·56	+8·12	− 2·44	13 55 19·02	37·78

1875, APRIL 21.

WITH THE BERLIN TRANSIT CIRCLE.

Level h. m.		s.	Collimation, including daily aberration	Azimuth
At 9	30 sid. time	−0·522		
At 14	0 „	−0·493	+0ˢ·103	−0ˢ·030

Epoch by Tiede 3	Name of star	Seconds of concluded clock time of transit over wire XI.	Sum of instrumental corrections	Seconds of star's R.A.	Clock correction
h. m.		s.	s.	s.	s.
13 25·8	δ Virginis	38·68	−0·25	20·27	+41·84
	ϵ Virginis	17·65	−0·30	59·17	41·82
	α Ursæ min. S.P.	54·40	...	...	...
	ζ Virginis	39·76	−0·22	21·31	41·77
	τ Boötis	39·93	−0·34	21·41	41·82
	η Boötis	4·58	−0·34	46·05	41·81
	τ Virginis	37·47	−0·24	19·02	41·79

WITH DR. LÖW'S TRANSIT INSTRUMENT.

Levellings E p.	Levellings W p.		Collimation, circle W	Azimuth
−0·78	−1·30	Mean level −0·74		
−0·22	−0·75	E −0ᵖ·59 = −0ˢ·065		
−0·38		W −0ᵖ·89 = −0ˢ·099	−1ˢ·139	−4ˢ·496

WITH DR. LÖW'S TRANSIT INSTRUMENT (*continued*).

Epoch by chronometer and assumed *hourly* chronometer rate	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Chronometer rate to epoch	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
h. m. s.			h. m. s.	s.	s.	h. m. s.	h. m. s.
11 25 0·00	δ Virginis	E	10 47 47·50	−6·22	− 2·27	12 49 20·28	+2 1 41·27
+10·033	ε Virginis	„	10 54 24·92	−5·11	− 1·89	12 55 59·18	41·26
	α Ursæ min. S.P.	„	11 12 51·85	−2·03	−165·06	1 11 45·98	[41·22]
	„ „	W	11 14·81	−2·30	− 67·74	„	
	ζ Virginis	„	11 26 44·80	+0·29	− 4·77	13 28 21·32	41·00
	τ Boötis	„	11 39 41·72	+2·45	− 3·96	13 41 21·42	41·21
	η Boötis	„	11 47 5·02	+3·69	− 3·93	13 48 46·06	41·28
	τ Virginis	E	11 53 35·29	+4·78	− 2·37	13 55 19·03	41·33

Taking the means of the separate groups, the results are :—

For Dr. Becker with the Berlin transit circle and clock Tiede 3 :—

Date, 1875	Epoch by clock	Clock correction to local sidereal time	*Hourly* rate
	h. m.	s.	s.
April 15	12 55·9	+38·50	
			+0·023
„ 20	13 6·2	+41·27	
			+0·022
„ 21	13 25·8	+41·81	

For Dr. Löw with his transit instrument and chronometer Tiede 340 :—

Date, 1875	Epoch by chronometer	Chronometer correction to local sidereal time	Adopted *hourly* rate
	h. m. s.	h. m. s.	s.
April 15	11 47 0·00	+1 37 40·08	
„ 20	11 9 0·00	+1 57 37·78	+10·036
„ 21	11 25 0·00	+2 1 41·22	

The means of the comparisons of Tiede 3 with Tiede 340 give :—

Date, 1875	Tiede 3	Tiede 340
	h. m. s.	h. m. s.
April 15	13 27 25·50	11 50 23·50
„ 20	13 8 8·40	11 11 11·60
„ 21	13 27 6·50	11 26 7·125

Applying the respective corrections, we find :—

Dr. Becker with Tiede 3 *makes the local sidereal time*

Date, 1875	h. m. s.
April 15	13 28 4·01
„ 20	13 8 49·67
„ 21	13 27 48·31

Dr. Löw with Tiede 340 *makes the local sidereal time*

Date, 1875	h. m. s.
April 15	13 28 4·15
„ 20	13 8 49·75
„ 21	13 27 48·53

Or :—

	s.
Löw − Becker	= +0·14
	+0·08
	+0·22

Therefore the final difference of personal equation :—

Löw − Becker = +0·15 s.

CHAPTER XIX.

OPERATIONS AT DUN ECHT.

In so far as they bear on the telegraphic longitudes, the operations at Dun Echt were of a two-fold character.

First, in the autumn of 1875 Mr. Gill, with the assistance of Mr. H. J. Carpenter, made experiments to determine his absolute personal equation in sending and receiving telegraphic signals.

Secondly, since Mr. Gill, as explained in Chapter XV., took all the observations for ascertaining the difference of longitude between the British Government astronomical station and that of Lord Lindsay at Suez, using Dr. Löw's instrument at one station and the altazimuth at the other, it became desirable for Mr. Gill to determine the change of his personal equation when using these two very dissimilar instruments. There being only one subsequent opportunity of comparing the two instruments during the operations on the journey—viz. at Alexandria—Dr. Löw's instrument was kindly lent by the German Government to Lord Lindsay after the return of the expedition. Mr. Gill was thus enabled to institute the desired comparisons at Dun Echt in the earlier part of 1876.

In the observations made by Mr. Gill and Mr. H. J. Carpenter to determine their absolute personal equations in sending and receiving telegraphic longitude signals, a sidereal chronometer was compared with a mean-time chronometer by coincident beats by both observers immediately before and after each set of observations; signals were then sent by each observer in turn by one of the chronometers, the other observer noting the time by the other chronometer, the object being to determine by these signals when the chronometers were beating exactly together. Two keys were used, one with a very strong spring, the other with a very weak one, to try if this made any difference; it will be seen, however, from the results that no appreciable difference can be traced to the strength of the spring. These keys are called 'hard key' and 'soft key' respectively. The observers were seated about two yards apart.

Thirteen sets of these experiments were made by each of the observers with each key on August 23, 24, September 3 and 4, 1875, of which it will be sufficient to give the first as a specimen.

1875, August 23.

Comparison of Chronometers.

Frodsham 5018			Walker 171			Frodsham 5018			Walker 171			Frodsham 5018			Walker 171		
h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
7	57	47·0	17	55	18·5	8	16	12·0	18	13	46·5	8	28	33·0	18	26	9·5
8	0	49·0	17	58	21·0	8	19	15·0	18	16	50·0	8	31	38·0	18	29	15·0

SIGNALS—MR. GILL SENDING BY FRODSHAM 5018; MR. CARPENTER RECEIVING BY WALKER 171.

Hard Key.

Time by Frodsham 5018			Time by Walker 171		
h.	m.	s.	h.	m.	s.
8	6	50·0	18	4	22·95
	7	0·0			32·95
		10·0			42·95
		20·0			52·98
		30·0		5	3·15
8	7	40·0	18	5	13·10

Soft Key.

Time by Frodsham 5018			Time by Walker 171		
h.	m.	s.	h.	m.	s.
8	22	10·0	18	19	45·45
		20·0			55·48
		30·0		20	5·48
		40·0			15·48
8	22	50·0	18	20	25·55

MR. CARPENTER SENDING BY FRODSHAM 5018; MR. GILL RECEIVING BY WALKER 171.

Hard Key.

Time by Frodsham 5018			Time by Walker 171		
h.	m.	s.	h.	m.	s.
8	12	50·0	18	10	23·95
	13	10·0			44·00
		20·0			54·00
		30·0		11	4·05
		40·0			14·00
8	13	50·0	18	11	24·05

Soft Key.

Time by Frodsham 5018			Time by Walker 171		
h.	m.	s.	h.	m.	s.
8	25	30·0	18	23	6·0
8	25	40·0	18	23	16·0

Twelve similar but somewhat longer sets were made in exactly the same manner.

Taking the means of the various sets, and interpolating between the chronometer comparisons immediately before and after, we find :—

FOR MR. GILL.

HARD KEY									SOFT KEY								
Time by Frodsham 5018			Time by Walker 171			Interpolated seconds of Frodsham 5018	Interpolated seconds of Walker 171	Interpolated *minus* observed times	Time by Frodsham 5018			Time by Walker 171			Interpolated seconds of Frodsham 5018	Interpolated seconds of Walker 171	Interpolated *minus* observed times
h.	m.	s.	h.	m.	s.	s.	s.	s.	h.	m.	s.	h.	m.	s.	s.	s.	s.
8	7	15·00	18	4	48·013	...	48·044	+0·031	8	22	30·00	18	20	5·488	...	5·527	+0·039
0	40	35·00	10	40	49·025	...	49·031	+0·006	0	43	35·00	10	43	49·508	...	49·514	+0·006
0	49	30·00	10	49	45·480	...	45·467	−0·013	0	46	40·00	10	46	54·990	...	55·010	+0·020
8	3	0·00	18	4	25·472	...	25·508	+0·036	8	6	5·00	18	7	30·990	...	31·007	+0·017
8	12	25·00	18	13	52·000	...	52·030	+0·030	8	9	22·50	18	10	49·020	...	49·039	+0·019
8	52	40·00	18	54	13·517	...	13·533	+0·016	8	49	35·00	18	51	8·015	...	8·035	+0·025
8	55	40·00	18	57	14·032	...	14·017	−0·015	8	58	50·00	19	0	24·516	...	24·529	+0·013
3	27	47·500	15	51	10·00	47·527	...	+0·027	3	24	43·012	15	48	5·00	43·022	...	+0·010
3	30	51·975	15	54	15·00	52·032	...	+0·057	3	33	46·566	15	57	10·00	46·563	...	−0·003
3	59	10·00	16	22	37·500	...	37·532	+0·032	4	2	20·00	16	25	48·006	...	48·046	+0·040
4	11	30·00	16	34	59·490	...	59·532	+0·042	4	8	30·00	16	31	59·023	...	59·046	+0·023
22	41	57·002	11	8	25·00	57·010	...	+0·008	22	45	1·500	11	11	30·00	1·516	...	+0·016
22	51	30·480	11	18	0·00	30·474	...	−0·006	22	48	1·020	11	14	30·00	1·035	...	+0·015
					Mean . . .			+0·019						Mean . . .			+0·018

FOR MR. CARPENTER.

HARD KEY									SOFT KEY								
Time by Frodsham 5018			Time by Walker 171			Interpolated seconds of Frodsham 5018	Interpolated seconds of Walker 171	Interpolated *minus* observed times	Time by Frodsham 5018			Time by Walker 171			Interpolated seconds of Frodsham 5018	Interpolated seconds of Walker 171	Interpolated *minus* observed times
h.	m.	s.	h.	m.	s.	s.	s.	s.	h.	m.	s.	h.	m.	s.	s.	s.	s.
8	13	23·333	18	10	57·342	...	57·377	+0·035	8	25	35·00	18	23	11·00	...	11·021	+0·021
0	27	45·00	10	27	57·000	...	56·963	−0·037	0	31	0·00	10	31	12·517	...	12·487	−0·030
0	37	3·333	10	37	16·840	...	16·795	−0·045	0	34	5·00	10	34	18·025	...	17·984	−0·041
8	15	30·00	18	16	57·502	...	57·529	+0·027	8	18	25·00	18	19	52·998	...	53·000	+0·002
8	24	15·00	18	25	43·982	...	43·943	−0·039	8	21	22·50	18	22	50·988	...	50·979	−0·009
8	39	35·00	18	41	6·498	...	6·420	−0·078	8	36	45·00	18	38	16·020	...	15·962	−0·058
8	42	50·00	18	44	22·025	...	21·945	−0·080	8	46	0·00	18	47	32·504	...	32·456	−0·048
3	42	55·029	16	6	20·00	55·090	...	+0·061	3	37	11·028	16	0	35·00	11·014	...	−0·014
3	46	29·500	16	9	55·00	29·515	...	+0·015	3	49	49·000	16	13	15·00	48·979	...	−0·021
4	14	25·00	16	37	54·997	...	55·005	+0·008	4	17	30·00	16	41	0·490	...	0·505	+0·015
4	23	40·00	16	47	11·450	...	11·505	+0·055	4	20	36·667	16	44	7·683	...	7·676	−0·007
22	29	24·005	10	55	50·00	24·028	...	+0·023	22	32	23·494	10	58	50·00	23·547	...	+0·053
22	38	37·507	11	5	5·00	37·545	...	+0·038	22	35	20·512	11	1	47·50	20·573	...	+0·061
					Mean . . .			−0·001						Mean . . .			−0·006

There being no personal equation between Mr. Gill and Mr. Carpenter in noting coincidence of beats of chronometers, and as these signals were observed as nearly as possible at the coincidences, we may assume that the error of *receiving* signals is practically zero. Assuming, therefore, that there is no personal equation in *receiving* signals, the whole of the differences in the preceding tables are due to personal equation in *sending* signals. Or—

	s.	s.
Mr. Gill sends signals too soon by 'Hard Key'	0·019	± 0·004
„ „ „ „ 'Soft Key'	0·018	± 0·002
Mr. Carpenter sends signals too late by 'Hard Key'	0·001	± 0·009
„ „ „ „ 'Soft Key'	0·006	± 0·007

In a letter dated May 6, 1880, Professor Auwers writes that he himself sends signals $0^{s}\cdot065$ too soon; the difference between this and Mr. Gill's result for 'Soft Key' gives

$$\text{Auwers–Gill} = +0^{s}\cdot047,$$

half of which must be added to the mean of signals sent to and fro when Professor Auwers is at the station of lesser longitude.

On the authority of the same letter, Dr. Löw sends signals $0^{s}\cdot013$ too late; we have, therefore, in sending signals, a further personal equation of

$$\text{Löw–Gill} = -0^{s}\cdot031,$$

half of which has still to be applied to the longitude determination between Suez and Alexandria, in which the signals were sent and received by relay at both stations.

Difference of Personal Equation between Mr. Gill observing with Dr. Löw's Transit Instrument and the Troughton and Simms' Altazimuth.

For the transit instrument the levellings were performed by reversing the axis with the level upon it. In this way the level-readings give the true mean level of the axis independent of pivot inequality. For this latter error the adopted correction of $-0^{p}\cdot15$ to the mean level has been used for all observations with circle west, and the same correction with opposite sign for circle east. The sign *plus* indicates that the readings increased towards the west, and *minus* that they were greatest at the east end. The observations with the altazimuth were made in the vertical of Polaris, and, having due regard to the construction of the instrument, the level was each time reversed upon the axis, exactly as had been done during the longitude operations.

Observations with Dr. Löw's Transit Instrument. Observer, Mr. Gill; Chronometer 'Walker 171.'

Date, 1876	Name of star	Position of circle	Seconds of transit over wires											Concluded chronometer time of transit over wire VI.			Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.					
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Feb. 22 (1st group)	8 Lyncis	E	31·7	6·5	49·4	...	33·0	...	58·8	...	42·0	24·8	59·5	6	26	15·69	−46·9	−20·5
																	+46·5	+20·0
																	+46·4	+20·0
																	−46·7	−20·3
	Cephei 51 H.	„	...	...	...	...	...	...	17·0	56·5	29·5	42·7	...	6	42	4·26	−46·8	−20·4
	„ „	W	...	...	...	...	...	32·0	16·0	39·0	4·0	...	...			30·28	+46·5	+20·1
	ζ Geminorum	„	0·3	13·3	...	26·15	...	39·0	...	51·9*	...	5·0	17·85	6	56	39·09	...	...
	λ Geminorum	„	13·95	26·5	...	39·0	...	51·3	...	...	...	17·0	29·7	7	10	51·69	...	...
	δ Geminorum	„	...	...	...	...	...	36·95	...	49·9	...	3·0	15·9	7	12	36·89	+46·7	+20·2
	ρ Geminorum	E	43·9	29·9	...	15·1	...	1·0	...	...	...	...	...	7	21	1·09	−46·5	−20·0
	α Canis min.	„	17·0	5·0	...	53·0	...	40·8†	...	28·8	...	16·3	4·3	7	32	40·72	...	...
	κ Geminorum	„	30·1	...	...	3·4	...	50·3	...	37·5	...	23·8	10·8	7	36	50·38	...	...
Feb. 22 (2nd group)	α Leonis	E	15·5	3·0	...	50·8	...	38·35	...	26·0	...	13·7	1·4	10	1	38·37	−47·0	−20·25
	37 Ursæ maj.	„	12·1	49·8	...	27·1	...	4·8	...	42·2	...	19·3	56·9	10	27	4·54	...	...
	41 Leonis min.	„	12·5	59·1	...	46·2	...	...	...	...	...	...	...	10	36	32·83	...	...
	42 Leonis min.	„	33·3	19·0	...	4·8	...	50·6	...	36·8	...	...	...	10	38‡	50·72	−47·0	−19·9
	β Ursæ maj.	W	11·0	33·3	...	55·7	...	17·7	...	39·8	...	2·2	24·0	10	54	17·73	+46·7	+19·8
																	+46·4	+19·3
	ψ Ursæ maj.	„	44·85	1·8	...	19·0	...	36·05	...	...	...	...	27·6	11	2	36·15	...	...
	δ Leonis	„	45·5	58·0	...	11·1	...	...	...	37·0	...	50·0	3·0	11	7	24·13	+47·0	+19·9
																	−47·0	−19·9
																	−47·0	−19·9
																	+46·8	+19·5

* 21″·9 in original. † 30″·8 in original. ‡ Minute supplied.

OBSERVATIONS WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH. OBSERVER, MR. GILL; CHRONOMETER 'WALKER 171.'

Date, 1876	Pole star	Position of circle	Chronometer time of Pole star on wire III.	Level readings	Time star	Chronometer times of transit over wires					Level readings
						I.	II.	III.	IV.	V.	
			h. m. s.	E p. W p.		s. s.	h. m. s.	s.	s.	E p. W p.
Feb. 22	α Ursæ min.	W	7 49 54·0	21·5 21·5 21·1 21·8	o Ursæ maj.	21·3 49·0	8 21 16·5	...	...	21·5 21·0 21·1 21·8
	" "	"	"	" "	ι Cancri	21·1 36·3	8 33 51·8	6·4	21·9	21·0 21·4 21·3 21·2
	" "	"	"	" "	ι Ursæ maj.	44·5 4·9	8 48 24·7	43·4	4·8	20·0* 22·6 22·2 20·3
	α Ursæ min.	E	9 3 46·0	23·9 18·8 25·6 16·9	38 Lyncis	55·8 39·0	9 7 21·9	5·9	49·0	24·5 18·0 23·0 19·4
	" "	"	"	" "	40 Lyncis	59·0 42·6	9 9 ...	...	...	" "
	α Ursæ min.	"	9 17 54·0	25·5 17·0 24·3 18·1	10 Leonis min.	30·7 14·0	9 22 57·5	41·4	24·3	23·0 19·6 23·2 19·2
	" "	"	"	" "	ν Ursæ maj.	41·5 14·8	9 42 49·0	22·8	56·6	23·5 19·2 22·7 20·2
	α Ursæ min.	W	9 53 57·0	19·0 23·8 20·0 22·8	λ Ursæ maj.	29·8 47·9	10 7† 6·6	24·4	42·7	21·0 22·0 21·1 21·8
	" "	"	"	" "	31 Leonis min.	53·7 9·9	10 17 27·0	43·4	0·0	" "

* (25P·0 17P·6) in original. † 8m in original.

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, MR. GILL; CHRONOMETER 'WALKER 171.'

Date, 1876	Name of star	Position of circle	Seconds of transit over wires											Concluded chronometer time of transit over wire VI.			Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.					
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Feb. 24 (1st group)	Cephei 51 H.‡	W	45·0	59·0	42·5	6·5	29·0	...	...	...	...	...	...	6	42	18·27	+48·5 −47·1 −47·0 +48·8	+18·5 −17·0 −16·9 +18·8
	" "	E	28·0	15·5	27·5	5·0	40·0	...	...	...	...	...	...		41	53·33	...	...
	λ Geminorum	"	17·8	5·0	...	52·5	...	39·9	...	27·35	...	14·5	2·0	7	10	39·84	...	...
	δ Geminorum	"	4·1	51·0	...	38·0	...	25·0	...	...	...	...	...	7	12	24·93	...	...
	ι Geminorum	W	3·9	17·3	...	31·1	...	44·8	...	58·5	...	12·2	25·9	7	17	44·83	...	...
	ρ Geminorum	"	8·9	23·0	...	37·3	...	51·5	...	...	...	20·2	34·3	7	20	51·59	+48·8 −48·0 −48·0 +49·0	+18·8 −18·0 −18·0 +18·9
Feb. 24 (2nd group)	Drac. 1 H.	E	...	...	...	...	...	...	13·0	45·3	16·0	19·0	...	9	19	9·88	+49·0 −49·3	+18·9 −18·0
	" "	W	...	...	...	...	...	...	15·5	43·0	12·8	10·3	...			18·84	+48·8 −47·8 −47·8 +48·9	+18·4 −17·4 −17·4 +18·5
	α Leonis	"	51·7	3·9	...	16·1	...	28·8	...	41·0	...	53·4	5·9	10	1	28·71		
	μ Ursæ maj.	"	51·45	7·8	...	24·0	...	40·2	...	56·5	...	12·9	29·1	10	14	40·31	...	...
	31 Leonis min.	"	40·7	55·9	...	11·05	...	26·3	36·2	...	46·4	...	11·8	10	20	26·23	...	...
	37 Ursæ maj.	E	1·5	38·9	...	16·1	...	...	...	...	...	...	...	10	27	53·58	...	...
	41 Leonis min.	"	1·6	48·4	...	35·1	...	22·05	...	9·0	...	55·7	42·5	10	35	22·03	...	...
	42 Leonis min.	"	22·4	8·0	...	54·0	...	40·05	...	26·0	...	11·4	...	10	38§	39·87	−17·6 +18·2 +18·3 −17·5	−48·2 +48·9 +49·0 −48·1

‡ Star very faint from mist. § 18m in original.

OBSERVATIONS WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH. OBSERVER, MR. GILL; CHRONOMETER 'WALKER 171.'

Date, 1876	Pole star	Position of circle	Chronometer time of Pole star on wire III.	Level readings	Time star	Chronometer time of transit over wires					Level readings
						I.	II.	III.	IV.	V.	
			h. m. s.	E p. W p.		s.	s.	h. m. s.	s.	s.	E p. W p.
Feb.24	α Ursæ min.	W	7 39 39·0	22·5 23·1 / 25·3 20·0	26 Lyncis*	...	...	7 43 3·8	22·9	42·9	22·6 22·5 / 23·9 21·3
	" "	"	"	" "	6 Cancri	43·9	58·8	7 50 14·0	28·8	43·9	" "
	α Ursæ min.	E	8 13 39·0	24·8 20·4 / 22·0 23·3	ο Ursæ maj.	59·8†	31·7	8 21 4·0	37·0	9·5	23·4 22·0 / 22·5 22·7 / 22·2 23·0 / 23·7 21·8 / 25·3 20·0 / 23·0 22·2 / 23·7 21·5 / 22·2 23·0
	" "	"	"	" "	δ Cancri	36·5	22·4	8 31 7·9	54·4	...	
	" "	"	"	" "	ε Cancri	20·6	5·5	8 33 50·3	35·4	19·9	
	α Ursæ min.	"	8 49 15·0	22·5 23·5 / 23·0 22·1	38 Lyncis	37·0	20·3	9 7 3·4	47·0	30·8	21·4 23·8 / 23·3 22·0 / 23·0 22·4 / 21·0 24·3
	" "	"	"	23·0 22·1 / 21·2 23·6	40 Lyncis	39·25	22·9	9 9 ...	51·0	34·7	
	α Ursæ min.	W	9 45 20·0	22·9 22·8 / 21·6 24·0	η Leonis	43·0	56·9	9 55 10·9	24·4	38·7	21·9 23·8 / 24·8 21·0 / 24·3 21·3 / 22·0 23·5
	" "	"	"	" "	λ Ursæ maj.	15·5	33·8	10 6 52·1	10·0	28·4‡	

* Observation not good. † 9ˢ·8 in original. ‡ 18ˢ·4 in original.

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, MR. GILL; CHRONOMETER 'WALKER 171.'

Date, 1876	Name of star	Position of circle	Seconds of transit over wires											Concluded chronometer time of transit over wire VI.	Level readings
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.		
			s.	s.		s.		s.	s.	s.	s.	s.	s.	h. m. s.	p. p.
Mar. 7	μ Geminorum	E	51·8	38·9	...	25·8	..	12·4	...	59·7	...	46·45	33·2	6 15 12·59	... ...
	γ Geminorum	"	55·7	43·0	...	...	...	17·9	...	5·4	...	...	...	6 30 17·86	... ...
	Cephei 51 H.	"	...	...	...	...	...	...	3·0	41·0	15·5	28·0	...	6 41 49·80	−17·3 −48·5 / −17·0 −48·5 / −17·0 −48·2
	" "	W	...	...	...	...	...	22·0	9·5	33·0	59·0	46·5	...	42 23·66	+16·6 +47·7 / +16·2 +47·4 / +16·6 +47·7
	β Geminorum	"	...	3·3	...	17·0	...	30·9	...	44·3	...	58·1	11·9	7 37§ 30·74	... ...
	6 Cancri	"	...	...	...	...	...	...	...	...	...	9·0	22·4	7 55 41·45	+17·1 +48·3 / −17·6 −48·9 / −17·1 −48·3 / +17·0 +48·1
	η Cancri	E	56·25	43·5	...	30·6	...	17·5	...	4·4	...	51·8	39·0	8 25‖ 17·56	... ...
	ι Cancri	"	38·8	24·95	...	11·0	...	57·1	...	43·4	...	29·4	...	8 38 57·16	−48·0 −17·0 / +47·7 +16·5 / +48·0 +16·9 / −48·2 −17·0

§ 42ᵐ in original. ‖ 26ᵐ in original.

OBSERVATIONS WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH. OBSERVER, MR. GILL; CHRONOMETER 'WALKER 171.'

Date, 1876	Pole star	Position of circle	Chronometer time of Pole star on wire III.	Level readings	Time star	Chronometer time of transit over wires					Level readings
						I.	II.	III.	IV.	V.	
			h. m. s.	E p. W p.		s.	s.	h. m. s.	s.	s.	E p. W p.
Mar. 7	α Ursæ min.	E	5 39 35·0	24·5 19·2 22·0 21·9	β Aurigæ	4·7	45·9	5 47 26·8	8·5	...	... ...
	α Ursæ min.	„	6 1 43·0	23·3 20·3 21·3 22·5	μ Geminorum	51·2	36·4	6 9 22·0	7·9	53·5	20·7 23·1 25·8 18·1
	„ „	„	„	20·5 23·0 23·4 20·2	γ Geminorum	18·0	4·1	6 23 50·1	36·7	22·5	
	α Ursæ min.	W	7 2 54·0	19·0 25·0 18·9 25·1 19·9 24·1 16·6 24·2	ι Geminorum	47·9	...	7 12 18·3	32·9	48·0	18·7 25·0 20·2 23·5 20·6 23·3 18·8 25·0 19·1 24·8 18·3 25·2 19·5 24·2 19·3 24·7
	„ „	„	„		κ Geminorum*	...	36·0	7 30 50·8	5·2	20·0	
	α Ursæ min.	„	7 42 7·0	... ..	6 Cancri	...	1·4	7 50 16·5	31·[illegible]	46·3	18·4 25·2 21·0 22·9 20·9 23·2 18·4 25·3
	α Ursæ min.	E	8 16 25·0	23·6 20·3 22·3 21·4 22·3 21·4 23·1 20·7	η Cancri	49·1	35·4	8 19 20·9	6·9	52·6	22·2 21·8 23·2 20·5 24·2 19·5 21·3 22·3 24·2 19·6 22·0 22·0 22·3 21·6 23·0 21·0
	„ „	„	„		ι Cancri	25·4	10·3	8 33 54·95	40·0	24·9	

* β Geminorum in original.

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, MR. GILL; CHRONOMETER 'WALKER 171.'

Date, 1876	Name of star	Position of circle	Seconds of transit over wires											Concluded chronometer time of transit over wire VI.			Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.					
			s.	s.	s.	s.	s.	s.				s.	s.	h.	m.	s.	p.	p.
Mar. 15	Cephei 51 H.	W	...	...	5·5	31·0	54·5	...	...	...	...	...	...	6	41	41·60	+48·0	+16·5
																	−49·1	−17·9
																	−49·4	−18·0
																	+48·0	+16·5
	„ „	E	...	...	46·0	21·0	57·0	...	...	...	...	...	...			10·06	+48·0	+16·4
																	−49·6	−18·0
	ι Geminorum	„	50·0	36·4	...	22·6	...	9·0	...	55·3	...	41·4	...	7	17	8·90	...	...
	κ Geminorum	„	45·0	31·9	...	18·3	...	5·1	...	52·0	...	38·4	25·1	7	36	5·09	...	...
	β Geminorum	„	32·4	18·7	...	...	...	...	...	...	...	...	...	7	36	51·22	−49·5	−17·8
																	+48·0	+16·0
																	+48·0	+16·2
																	−49·7	−17·9
	κ Ursæ maj.†	W	...	44·0	...	2·0	...	[18·1‡]	...	38·0	...	55·9	13·8	8	54	20·02	...	...
	36 Lyncis	„	1·8	18·1	...	34·9	...	[50·1‡]	...	8·4	...	25·0	...	9	4	51·72	...	...

† Snow squall. [‡] These wires discordant, probably owing to the neighbourhood of the movable wire; rejected.

OBSERVATIONS WITH DR. LÖW'S TRANSIT INSTRUMENT. OBSERVER, MR. GILL; CHRONOMETER 'WALKER 171'—(*continued*).

Date, 1876	Name of star	Position of circle	Seconds of transit over wires											Concluded chronometer time of transit over wire VI.			Level readings	
			I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.					
			s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	h.	m.	s.	p.	p.
Mar. 15 (*cont.*)	10 Leonis min.	W	...	16·9	...	32·2	...	[45·9*]	...	2·4	...	17·8	32·8	9	25	47·38	...	...
	ϵ Leonis	,,	...	...	...	...	...	...	...	11·0	...	24·8	37·8	9	37	58·05	...	...
	μ Leonis	,,	11·5	24·8	...	38·5	...	[50·8*]	...	5·4	...	19·0	32·5	9	44	51·98	...	...
	μ Ursæ maj.	,,	...	34·1	...	50·2	...	[5·0*]	...	23·05	...	39·25	55·5	10	14	6·69	...	...
	Drac. 9 H.	,,	...	...	43·0	59·8	17·0	51·3	25·0	42·0	59·5	34·0	24·7	10	23	51·23	+48·3 +16·0 −49·6 −17·0 −49·8 −17·3 +48·5 +16·0	
	ψ Ursæ maj.	E	41·4	24·0	...	7·0	...	49·9	...	...	...	...	...	11	1	49·86		
	58 Ursæ maj.	,,	47·0	30·0	...	13·3	...	56·6	...	...	...	...	...	11	22	56·57	...	...
	β Leonis	,,	28·95	16·35	...	3·8	...	51·4	...	38·9	...	26·1	13·9	11	41	51·32	−49·9 −17·0 +48·1 +15·3 +48·1 +15·5 −49·4 −16·5	

[*] These wires discordant; rejected.

OBSERVATIONS WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH. OBSERVER, MR. GILL; CHRONOMETER 'WALKER 171.'

Date, 1876	Pole star	Position of circle	Chronometer time of Pole star on wire III.			Level readings		Time star	Chronometer times of transit over wires						Level readings	
									I.	II.	III.			IV.	V.	
			h.	m.	s.	E p.	W p.		s.	s.	h.	m.	s.	s.	s.	E p.	W p.
Mar. 15	α Ursæ min.	W	7	1	51·0	17·4 18·4 18·4 17·5	26·5 25·5 25·6 26·3	ι Geminorum	11·6	26·8	7	11	41·9	56·3	11·7	18·0 19·8 19·0 18·4 17·9 19·4	26·0 24·4 25·0 25·3 26·1 24·9
	,, ,,	,,		,,				κ Geminorum	45·5	59·8	7	30	14·2	28·8	43·4		
	,, ,,	,,		,,		...	...	β Geminorum †	...	10·8	7	31‡	25·8	40·5	...		
	α Ursæ min.	E	8	44	1·0	22·5 21·2	21·9 23·0	10 Ursæ maj.	11·0	53·1	8	48	35·0	17·8	59·9	22·3 21·6 21·8	22·0 22·6 22·5
	,, ,,	,,		,,		21·1 22·3	23·1 21·9	36 Lyncis	31·9	13·7	9	1	55·0	37·3	18·9	21·1 20·5 21·9	23·1 23·7 22·3
	α Ursæ min.	,,	9	15	3·0	...	...	10 Leonis min.	41·3	24·9	9	22	8·0	52·0	35·3	22·8 21·8 21·3 22·3 22·1 21·2	21·8 22·7 23·0 22·0 22·1 23·1
	,, ,,	,,		,,		...	...	ϵ Leonis	26·5	11·9	9	32	57·5	43·2	28·5		
	,, ,,	,,		,,		...	...	μ Leonis	34·2	19·2	9	40	4·4	50·0	35·0		
	α Ursæ min.	,,	10	8	30·0	22·0 22·5 21·4 23·0 22·8 22·2	22·2 21·9 23·0 21·3 21·3 22·2	μ Ursæ maj.	14·3	56·2	10	11	38·2	20·9	2·9	23·2 21·5 22·0 22·9	21·0 22·9 22·4 21·9
	,, ,,	,,		,,				ρ Leonis	40·2	26·8	10	20	13·2	...	...		
	α Ursæ min.	W	11	12	7·0	22·5 21·8 21·3 23·0	22·2 23·0 23·0 21·6	58 Ursæ maj.	51·7	10·1	11	21	28·5	46·7	5·1	23·0 22·1 21·5 23·5	21·9 22·5 23·3 21·5
	,, ,,	,,		,,				β Leonis	8·5	...	11	38	36·1	49·8	3·7		

† Bad definition.

‡ Minute supplied.

Reducing the preceding observations as before, we get :—

WITH DR. LÖW'S TRANSIT INSTRUMENT.

Assumed chronometer rate +0ˢ·173 per hour ; this rate has not been introduced into the reductions, but has been merely used in the calculation of the azimuth.

	Level				Collimation, circle W	Azimuth
	p.	s.	p.	s.	s.	s.
1st group . .	E = +0·03	= +0·003	W = −0·27	= −0·030	−0·612	+1·409
2nd group . .	E = +0·10	= +0·011	W = −0·20	= −0·022	,,	,,

Date, 1876	Epoch by chronometer	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m.			h. m. s.	s.	h. m. s.	s.
Feb. 22 (1st group)	7 10·4	δ Lyncis	E	6 26 15·69	+ 1·07	6 26 23·83	+7·07
		Cephei 51 H.	,,	6 42 4·26	− 1·89	6 42 9·75	[7·38]
		,, ,,	W	30·28	−27·91	,,	
		ζ Geminorum	,,	6 56 39·09	+ 0·21	6 56 46·81	7·51
		λ Geminorum	,,	7 10 51·69	+ 0·29	7 10 59·56	7·58
		δ Geminorum	,,	7 12 36·89	+ 0·18	7 12 44·65	7·58
		ρ Geminorum	E	7 21 1·09	+ 1·43	7 21 9·93	7·41
		α Canis min.	,,	7 32 40·72	+ 1·73	7 32 50·01	7·56
		κ Geminorum	,,	7 36 50·38	+ 1·50	7 36 59·42	7·54
Feb. 22 (2nd group)	10 43·7	α Leonis	E	10 1 38·37	+ 1·64	10 1 47·95	+7·94
		37 Ursæ maj.	,,	10 27 4·54	+ 1·14	10 27 13·60	7·92
		41 Leonis min.	,,	10 36 32·83	+ 1·53	10 36 42·47	8·11
		42 Leonis min.	,,	10 38 50·72	+ 1·45	10 39 0·37	8·20
		β Ursæ maj.	W	10 54 17·73	− 1·17	10 54 24·69	8·13
		ψ Ursæ maj.	,,	11 2 36·15	− 0·48	11 2 44·11	8·44
		δ Leonis	,,	11 7 24·13	+ 0·21	11 7 32·81	8·47

WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH.

Assumed chronometer rate +0ˢ·200 per hour ; c = +0ˢ·106.

Date, 1876	Epoch by chronometer	Name of star	Position of circle	C	Concluded chronometer time of transit over wire III.	R.A. of star, including daily aberration	Rate of chronometer to epoch	t−m	Cc	Chronometer correction
	h. m.				h. m. s.	h. m. s.	s.	m. s.	s.	s.
Feb. 22	9 16·7	o Ursæ maj.	W	−1·808	8 21 16·58	8 20 0·70	+0·18	+1 23·84	−0·19	+7·95
		ι Cancri	,,	−2·140	8 33 51·67	8 39 13·64	+0·14	−5 13·79	−0·23	8·09
		ι Ursæ maj.	,,	−1·930	8 48 24·69	8 50 45·62	+0·09	−2 12·47	−0·20	8·35
		38 Lyncis	E	+2·051	9 7 22·13	9 11 9·92	+0·03	−3 39·81	+0·22	8·23
		40 Lyncis	,,	+2·078	9 9 26·40	9 13 32·25	+0·02	−3 57·93	+0·22	8·16
		10 Leonis min.	,,	+2·055	9 22 57·39	9 26 39·89	−0·02	−3 34·69	+0·22	8·01
		υ Ursæ maj.	,,	+1·822	9 42 48·64	9 42 13·57	−0·09	+0 43·41	+0·19	8·44
		λ Ursæ maj.	W	−1·983	10 7 6·49	10 9 39·62	−0·17	−2 24·45	−0·21	8·30
		31 Leonis min.	,,	−2·051	10 17 26·99	10 20 45·13	−0·20	−3 9·41	−0·22	8·31

With Dr. Löw's Transit Instrument.

Assumed chronometer rate for calculation of azimuth +0·240 per hour.

	Level				Collimation, circle W	Azimuth
	p.	s.	p.	s	s.	s.
1st group . .	E = +0·78	= +0·087	W = +0·48	= +0·053	−0·586	+1·547
2nd group . .	E = +0·60	= +0·067	W = +0·30	= +0·033	−0·618	

Date, 1876	Epoch by chronometer	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m.			h. m. s.	s.	h. m. s.	s.
Feb. 24 (1st group)	7 15·4	Cephei 51 H.	W	6 42 18·27	−27·45	6 42 9·11	[+18·13]
		„ „	E	41 53·33	− 2·19	„	
		λ Geminorum	„	7 10 39·84	+ 1·74	7 10 59·54	+17·96
		δ Geminorum	„	7 12 24·93	+ 1·68	7 12 44·63	18·02
		ε Geminorum	W	7 17 44·83	+ 0·22	7 18 3·22	18·17
		ρ Geminorum	„	7 20 51·59	+ 0·13	7 21 9·91	18·19
Feb. 24 (2nd group)	10 23·1	Drac. 1 H.	E	9 19 9·88	+ 0·08	9 19 28·62	[+18·52]
		„ „	W	18·84	− 8·56	„	
		α Leonis	„	10 1 28·71	+ 0·52	10 1 47·96	+18·73
		μ Ursæ maj.	„	10 14 40·31	− 0·23	10 14 59·02	18·94
		31 Leonis min.	„	10 20 26·23	− 0·05	10 20 45·14	18·96
		37 Ursæ maj.	E	10 27 53·58	+ 1·20	10 27 13·62	18·84
		41 Leonis min.	„	10 35 22·03	+ 1·64	10 36 42·49	18·82
		42 Leonis min.	„	10 38 39·87	+ 1·55	10 39 0·39	18·97

With the Troughton and Simms' Altazimuth.

Assumed chronometer rate +0·253 per hour; c = +0·080.

Date, 1876	Epoch by chronometer	Name of star	Position of circle	C	Concluded chronometer time of transit over wire III.	R.A. of star, including daily aberration	Rate of chronometer to epoch	t−m	Cc	Chronometer correction
	h. m.				h. m. s.	h. m. s.	s.	m. s.	s.	s.
Feb. 24	8 48·6	26 Lyncis	W	−1·937	7 43 3·68	7 45 43·22	+0·28	−2 21·20	−0·16	+18·46
		6 Cancri	„	−2·153	7 50 14·05	7 55 55·99	+0·24	−5 23·64	−0·17	18·37
		o Ursæ maj.	E	+1·808	8 21 4·09	8 20 0·67	+0·12	+1 21·93	+0·14	18·77
		δ Cancri	„	+2·276	8 31 8·16	8 37 40·12	+0·07	−6 13·88	+0·18	18·33
		ι Cancri	„	+2·140	8 33 50·17	8 39 13·62	+0·06	−5 5·26	+0·17	18·42
		38 Lyncis	„	+2·051	9 7 3·51	9 11 9·93	−0·08	−3 48·41	+0·16	18·09
		40 Lyncis	„	+2·078	9 9 6·73	9 13 32·25	−0·09	−4 7·12	+0·17	18·48
		η Leonis	W	−2·299	9 55 10·94	10 0 36·34	−0·28	−5 6·52	−0·18	18·42
		λ Ursæ maj.	„	−1·983	10 6 52·17	10 9 39·64	−0·33	−2 28·55	−0·16	18·43

WITH DR. LÖW'S TRANSIT INSTRUMENT.

Assumed chronometer rate for calculation of azimuth +0·252 per hour.

Level E = −0·09 = −0·010 (p. / s.) W = −0·39 = −0·043 (p. / s.) — Collimation, circle W −0·801 (s.) — Azimuth +1·515 (s.)

Date, 1876	Epoch by chronometer	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m.			h. m. s.	s.	h. m. s.	s.
Mar. 7	7 37·0	μ Geminorum	E	6 15 12·59	+ 1·81	6 15 28·67	+ 14·27
		γ Geminorum	„	6 30 17·86	+ 1·86	6 30 34·10	14·38
		Cephei 51 H.	„	6 41 49·80	+ 0·68	6 42 4·81	[14·33]
		„ „	W	42 23·66	−33·18	„	
		β Geminorum	„	7 37 30·74	− 0·12	7 37 45·33	14·71
		6 Cancri	„	7 55 41·45	− 0·12	7 55 55·87	14·54
		η Cancri	E	8 25 17·56	+ 1·80	8 25 34·04	14·68
		ι Cancri	„	8 38 57·16	+ 1·71	8 39 13·55	14·68

WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH.

Assumed chronometer rate +0·252 per hour (s.); c = +0·142 (s.).

Date, 1876	Epoch by chronometer	Name of star	Position of circle	C	Concluded chronometer time of transit over wire III.	R.A. of star, including daily aberration	Rate of chronometer to epoch	t − m	Cc	Chronometer correction
	h. m.				h. m. s.	h. m. s.	s.	m. s.	s.	s.
Mar. 7	7 13·4	β Aurigæ	E	+1·964	5 47 26·91	5 50 27·21	+0·36	−2 45·91	+0·28	+15·03
		μ Geminorum	„	+2·212	6 9 22·03	6 15 28·67	+0·27	−5 52·97	+0·31	14·25
		γ Geminorum	„	+2·290	6 23 50·12	6 30 34·10	+0·21	−6 30·20	+0·33	14·32
		ι Geminorum	W	−2·151	7 12 18·21	7 18 3·06	0·00	−5 29·96	−0·31	14·58
		κ Geminorum	„	−2·192	7 30 50·88	7 36 59·28	−0·07	−5 53·53	−0·31	14·49
		6 Cancri	„	−2·153	7 50 16·51	7 55 55·87	−0·15	−5 24·59	−0·31	14·31
		η Cancri	E	+2·246	8 19 20·82	8 25 34·04	−0·28	−5 58·91	+0·32	14·35
		ι Cancri	„	+2·140	8 33 54·94	8 39 13·55	−0·34	−5 4·16	+0·30	14·41

WITH DR. LÖW'S TRANSIT INSTRUMENT.

Assumed chronometer rate for calculation of azimuth +0·108 per hour.

Level E = −0·57 = −0·063 (p. / s.) W = −0·87 = −0·097 (p. / s.) — Collimation, circle W −0·745 (s.) — Azimuth +1·465 (s.)

Date, 1876	Epoch by chronometer	Name of star	Position of circle	Concluded chronometer time of transit over wire VI.	Sum of instrumental corrections	R.A. of star, including daily aberration	Chronometer correction
	h. m.			h. m. s.	s.	h. m. s.	s.
Mar. 15	9 28·2	Cephei 51 H.	W	6 41 41·60	−32·56	6 42 1·40	[+52·36]
		„ „	E	10·06	− 1·02	„	
		ι Geminorum	„	7 17 8·90	+ 1·60	7 18 2·93	+52·43
		κ Geminorum	„	7 36 5·09	+ 1·62	7 36 59·17	52·46
		β Geminorum	„	7 36 51·22	+ 1·59	7 37 45·20	52·39
		κ Ursæ maj.	W	8 54 20·02	− 0·89	8 55 11·94	52·81
		36 Lyncis	„	9 4 51·72	− 0·69	9 5 43·96	52·93
		10 Leonis min.	„	9 25 47·38	− 0·40	9 26 39·82	52·84
		ε Leonis	„	9 37 58·05	− 0·03	9 38 50·79	52·77
		μ Leonis	„	9 44 51·98	− 0·09	9 45 44·75	52·86
		μ Ursæ maj.	„	10 14 6·69	− 0·63	10 14 59·05	52·99
		Drac. 9 H.	„	10 23 51·23	− 5·59	10 24 38·75	[53·11]
		ψ Ursæ maj.	E	11 1 49·86	+ 1·40	11 2 44·30	53·04
		58 Ursæ maj.	„	11 22 56·57	+ 1·42	11 23 51·27	53·28
		β Leonis	„	11 41 51·32	+ 1·73	11 42 46·17	53·12

WITH THE TROUGHTON AND SIMMS' ALTAZIMUTH.

Assumed chronometer rate $+0^{s}.108$ per hour ; $c = -0^{s}.921$.

Date, 1876	Epoch by chronometer	Name of star	Position of circle	C	Concluded chronometer time of transit over wire III.	R.A. of star, including daily aberration	Rate of chronometer to epoch	t−m	Cc	Chronometer correction
	h. m.			s.	h. m. s.	h. m. s.	s.	m. s.	s.	s.
Mar. 15	9 20·9	ι Geminorum	W	−2·151	7 11 41·85	7 18 2·93	+0·23	−5 30·42	+1·98	+52·87
		κ Geminorum	„	−2·192	7 30 14·51	7 36 59·17	+0·20	−5 54·00	+2·02	52·88
		β Geminorum	„	−2·148	7 31 25·86	7 37 45·20	+0·20	−5 28·38	+1·98	53·14
		10 Ursæ maj.	E	+1·996	8 48 35·16	8 52 37·59	+0·06	−3 7·87	−1·84	52·78
		36 Lyncis	„	+1·981	9 1 55·15	9 5 43·96	+0·03	−2 53·95	−1·82	53·07
		10 Leonis min.	„	+2·055	9 22 8·11	9 26 39·82	0·00	−3 37·27	−1·89	52·55
		ε Leonis	„	+2·205	9 32 57·35	9 38 50·79	−0·02	−4 58·87	−2·03	52·52
		μ Leonis	„	+2·177	9 40 4·39	9 45 44·75	−0·03	−4 45·78	−2·00	52·55
		μ Ursæ maj.	„	+1·999	10 11 38·29	10 14 59·05	−0·09	−2 25·57	−1·84	53·26
		ρ Leonis	„	+2·409	10 20 13·20	10 26 18·85	−0·11	−5 10·10	−2·22	53·22
		58 Ursæ maj.	W	−1·981	11 21 28·62	11 23 51·27	−0·22	−1 31·76	+1·82	52·49
		β Leonis	„	−2·334	11 38 36·27	11 42 46·17	−0·25	−3 18·96	+2·15	52·84

Taking the means of the separate groups, we have :—

1876, FEBRUARY 22.

With Dr. Löw's Transit Instrument.

	Epoch by chronometer	Chronometer correction to local sidereal time	
	h. m.	s.	s.
1st group	7 10·4	Circle E +7·395 „ W 7·557	+7·48
2nd group	10 43·7	Circle E +8·042 „ W 8·343	+8·19

With the Troughton and Simms' Altazimuth.

Epoch by chronometer	Chronometer correction to local sidereal time	
h. m.	s.	s.
9 16·7	Circle E +8·210 „ W 8·202	+8·21

Hourly chronometer rate . . . +0·200

1876, FEBRUARY 24.

With Dr. Löw's Transit Instrument.

	Epoch by chronometer	Chronometer correction to local sidereal time	
	h. m.	s.	s.
1st group	7 15·4	Circle E +17·990 „ W 18·180	+18·09
2nd group	10 23·1	Circle E +18·877 „ W 18·877	+18·88

With the Troughton and Simms' Altazimuth.

Epoch by chronometer	Chronometer correction to local sidereal time	
h. m.	s.	s.
8 48·6	Circle E +18·418 „ W 18·420	+18·42

Hourly chronometer rate . . . +0·253

1876, MARCH 7.

With Dr. Löw's Transit Instrument.

Epoch by chronometer	Chronometer correction to local sidereal time	
h. m.	s.	s.
7 37·0	Circle E +14·502 „ W 14·625	+14·56

With the Troughton and Simms' Altazimuth.

Epoch by chronometer	Chronometer correction to local sidereal time	
h. m.	s.	s.
7 13·4	Circle E +14·472 „ W 14·460	+14·47

Hourly chronometer rate . . . + 0·165

1876, MARCH 15.

With Dr. Löw's Transit Instrument.

Epoch by chronometer	Chronometer correction to local sidereal time	
h. m.	s.	s.
9 28·2	Circle E +52·787 „ W 52·867	+52·83

With the Troughton and Simms' Altazimuth.

Epoch by chronometer	Chronometer correction to local sidereal time	
h. m.	s.	s.
9 20·9	Circle E +52·850 „ W 52·844	+52·85

Hourly chronometer rate . . . + 0·108

Using the chronometer rates given for each day to reduce the observations with each instrument to the same epoch, we get the following corrections to local sidereal time :—

	With Dr. Löw's Transit Instrument	With the Altazimuth
	s.	s.
1876, February 22 . . .	+ 7·90	+ 8·21
„ February 24 . . .	+18·48	+18·42
„ March 7	+14·50	+14·47
„ March 15	+52·82	+52·85

Or :—

		s.		
Transit instrument	− Altazimuth =	−0·31	Weight 4	at Dun Echt
„	„	+0·06	„ 4	
„	„	+0·03	„ 4	
„	„	−0·03	„ 5	
„	„	+0·03	„ 4	at Alexandria (p. 349)

Therefore the final difference of personal equation between Mr. Gill observing with the two instruments is :—

Transit instrument − Altazimuth = − 0^{s}·04

CHAPTER XX.

DETERMINATION OF LATITUDES OF SUEZ, PAMPLEMOUSSES, BELMONT, AND ALEXANDRIA BY CIRCUM-MERIDIAN ALTITUDES.

THE instrument used in these observations was the altazimuth by Troughton and Simms. The aperture of the telescope is 2·00 inches. There are three ordinary eye-pieces (powers of 37, 40, and 64), to all of which a diagonal prism can be attached. The general arrangement of the mounting—a straight telescope in the middle of the axis, between two uprights—however, prevents the observer's eye from being conveniently applied to the eye-pieces at zenith distances of less than about 20°, even when the diagonal prism is used. To obviate this difficulty a long diagonal eye-piece is provided, which may be best described as an erecting eye-piece with a diagonal speculum between the third and fourth lenses, counting from the eye end. With it zenith observations can be conveniently taken, but it is greatly to be feared that its use introduces a dangerous element of flexure; the magnifying power, too, is rather low, being only 30 diameters. The vertical and horizontal circles are both divided to 5′, and read by microscopes to single seconds, with tenths by estimation. The horizontal circle alone can be rotated to change the zero-point; but it has only two microscopes, while the altitude circle has four.

Every degree is numbered on both circles from 0° to 359°, the tens in full and the others by single figures. On the vertical circle the numbers increase in the direction of increasing geometrical angles, but on the horizontal circle the reverse is the case. In measuring altitudes the vertical circle moves with the telescope, but for horizontal angles the microscopes are carried round over the stationary circle. It therefore follows in both cases, that for an observer looking at the circles, a rotation in the direction of increasing angles is opposed to the order of the engraved numbers. This peculiarity has doubtless in some cases given rise to errors in setting or reading.

Two spirit-levels, marked I and II., are permanently attached to the frame carrying the four microscopes of the vertical circle. The divisions are numbered from the centre both ways. For an observer facing the circle those to the left have been called positive, and those to the right negative. In this way the resulting level correction comes out with its proper sign. The scale values were determined at Dun Echt in the spring of 1874 as follows:—

Level I.; 1 part = 2″·74 ± 0″·04
Level II.; 1 part = 2″·02 ± 0″·05

These quantities have been used in all the reductions.

A complete determination of latitude consists of two observations, generally of the same star, in reversed positions of the instrument. The following was the usual plan of observation. The telescope having been set to the approximate zenith distance, the star was bisected by the

middle horizontal wire some minutes before culmination. Both levels were first read off, then the degrees and next preceding 5′ division of the pointer, then the preceding and following divisions in the four microscope-micrometers ; a repetition of the level readings completed the first half of the observation. After reversal the same operations were repeated. An entire observation thus consists of eight complete level readings, readings of 16 divisions of the circle, two records of time, and two rough readings of the pointer. The indications of the barometer and thermometer were occasionally recorded.

Columns 1 to 12 of the next table contain all the particulars of the original observations excepting the reading of the pointer, which is practically given in the concluded circle reading. Whenever it has been found necessary to deviate from the original records the fact is stated in a note, or where numbers had to be interpolated, as in the case of the barometer and thermometer readings, the figures are enclosed in square brackets, [ ].

When one of the micrometer screws is turned forwards, the micrometer wires first come into coincidence with what, in the table, has been called the *preceding division*, and after about five further rotations into coincidence with the *following division*. It is the reading for this following division, corrected for run, which is added to the indication of the pointer to obtain the circle reading. The designation of the *following division* on the circle is, however, 5′ *less* than that of the *preceding* one. The headings of the remaining columns in the first half of the table render their contents sufficiently intelligible. A few words will suffice for the reductions, the chief particulars of which are given in the thirteenth and succeeding columns. If p and f are the readings of the preceding and following divisions, the correction for run is given by the formula

$$\text{Correction} = (p - f)\frac{f}{300}.$$

The mean of the four microscopes, thus corrected, added to the indication of the pointer, gives the concluded circle reading.[1] The reduction to the meridian has been computed by Delambre's formula, or in extreme cases by the direct method. Δ Ref. is the refraction on the reduction to the meridian. The concluded circle reading, corrected for level, reduction to the meridian, and Δ Ref., gives the meridional circle reading. This, combined with the corresponding value derived from an observation with the instrument reversed, gives the apparent meridional zenith distance, not shown in the table.

Bessel's refraction tables, modified by Sir George Airy, were used for computing the meridional refraction. In the absence of a certain identification of the meteorological instruments the uncorrected readings have been used, but, as all the instruments were verified at Kew, the errors from this source are known to be very small. At Pamplemousses the height of the barometer has been corrected for the difference of the attached and external thermometers.

The declinations (and right ascensions) of the stars are taken by preference from Professor Boss' Catalogue,[2] and, failing this, from the Greenwich Nine-Year or some earlier Catalogue, the First Melbourne Catalogue, or from that of the Cape Observatory for 1860. In every case the systematic corrections in declination deduced by Professor Boss for the various catalogues have been applied. The right ascensions are taken from the same authorities. The mean places for 1874·0 are given in Appendix II. The other columns of the table explain themselves.

[1] Whenever microscope *C* reads 0 revolutions and the reading of one of the other microscopes falls below zero, the fact is indicated by a note of exclamation ; 60 *p.* must be subtracted from every reading so marked.

[2] Professor Boss most kindly forwarded a set of proof-sheets of his Catalogue to Mr. Gill, and thus enabled us to use a uniform system of declinations for all the stars observed.

ALTITUDE OBSERVATIONS. PART I. OBSERVATIONS AND REDUCTIONS

Date, 1874	Position of circle	Star	Time by chronometer	Level I.		Level II.		Microscopes: preceding and following divisions					Barometer	Thermometer
								C		D	E	F		
			h. m. s.	p.	p.	p.	p.	r.	p.	p.	p.	p.	in.	°
July 7	W	α Ursæ min.	12 33 8·0	+21·5	−14·2	+25·7	−10·0		25·2	30·5	29·2	51·9	29·85*	82
				+24·0	−12·0	+27·3	− 7·8	1	22·8	32·8	32·8	52·1		
	E	„	12 42‡ 53·0	+10·5	−25·5	+12·5	−23·5		5·7	3·0	5·0	13·1		
				+ 9·5	−26·6	+11·1	−24·8	4	1·4	2·9	7·8	13·0		
	W	κ Ophiuchi	14 29 22·0	+17·7	−19·0	+22·6	−14·1‖		21·2	15·6	21·9	23·9		79
				+17·6	−19·0	+23·0	−13·7¶	4	25·2	14·1	26·1	25·8		
	E	„	14 35 23·0	+17·0	−19·6	+19·8**	−17·0		9·2	8·5	11·0	20·0		
				+16·9	−19·5	+19·8	−17·1	0	4·7	8·0	11·3	23·2		
	W	β Draconis	14 50 50·5	+16·9	−19·7	+21·1	−15·5		49·4	47·0	49·9	62·0		76
				+17·0	−19·2	+21·2	−15·5	0	48·2	51·5	52·5	63·9		
	E	„	15 2 1·0	+17·8	−18·9	+21·2	−15·4		62·7	51·2	60·0	62·7		
				+18·2	−18·3	+21·5	−15·3	1	64·3	53·3	63·9	65·0		
	E	α Ophiuchi	15 10 11·0	+18·2	−18·3	+21·9	−15·2		30·2	30·5	29·4	43·3		76
				+18·0	−18·2	+21·0	−16·0	1	29·3	32·5	35·5	43·5		
	W	„	15 20 52·5	+14·2	−22·3	+17·8	−19·4		15·5	6·5	11·2	17·0		
				+13·9	−22·9	+17·5	−19·3	2	12·2	7·0	14·1	15·2		
July 8	E	β Draconis	14 42 36·5	+11·9	−24·5	+16·7	−20·0		25·7	17·1	13·1	23·3	29·87	77·5
				+11·5	−25·0	+16·0	−20·7	0	22·1	18·7	16·9	23·2		
	W	„	14 48 26·0	+18·5	−18·0	+24·1	−12·4		24·2	29·3	19·0	38·5		
				+18·2	−18·0	+24·1	−12·5	2	23·2	29·4	24·1	38·2		
	W	β Draconis	14 54 14·7	+18·0	−18·1	+24·0	−12·5		51·0	56·7	50·2	64·4		77·5
				+18·1	−18·2	+23·8	−12·9	4	48·0	57·8	52·2	62·8		
	E	„	14 59 54·0	+12·2	−24·1	+16·0	−21·0		9·8	3·9	2·1	9·9		
				+12·0	−24·5	+16·0	−21·0	3	4·0	5·0	4·4	12·0		
	E	α Ophiuchi	15 5 35·5	+16·8	−18·6	+21·0	−16·0		17·5	21·8	14·6	31·0		77·1
				+16·9	−19·8	+21·0	−15·5	2	18·2	24·5	15·4	30·0		
	W	„	15 10 12·0	+18·1	−18·4	+23·9	−13·0		34·0	25·8	22·0	32·5		
				+18·0	−18·2	+23·9	−13·0	0	29·5	28·0	24·7	33·0		
	W	72 Ophiuchi	15 28 29·5	+15·9	−20·5	+21·5	−15·2		31·7	24·6	23·0	32·1		77·1
				+16·8	−19·6	+21·4	−15·3	0	32·2	27·0	24·2	34·0		
	E	„	15 34 45·0	+18·1	−18·5	+23·0	−14·2		26·5	30·8	29·0	41·0		77·1
				+18·2	−18·3	+23·0	−14·1	4	25·9	33·5	34·0	43·0		

h. m.
1874, July 7, at 14 56 chronometer time ;
„ „ 8, at 14 36 „ „

* The barometer reading was made each evening at 9 p.m. on the S.S. 'Mirzapore' by the Chief Officer. The barometer was certified by the Board of Trade. There was little difference of level between the deck of the ship and the observing station.

‡ 43ᵐ in original ; for one minute $\Delta z = 10''{\cdot}75$. ‖ 19·1 in original. ¶ 18·7 in original.

** 24·8 in original. The corrections make the length of the bubble about what it must have been. The original entries would indicate a temperature of about 44° Fahr. (See note to observations at Alexandria.)

OF CIRCUM-MERIDIAN ALTITUDES AT SUEZ. OBSERVER, MR. GILL.

Concluded circle reading	R.A. of star	Correction for			Meridional		Declination of star	Latitude
		Level	Reduction to meridian	△ Ref.	Circle reading	Refraction		
° ′ ″	h. m. s.	″	′ ″	″	° ′ ″	″	° ′ ″	° ′ ″
317† 46 34·82	1 12 23·38	+15·50	− 7 59·83	+ ·55	317 38 51·04			
						99·31	+88 38 3·55	+29 58 1·64
80 14§ 6·60		−17·23	+ 9 33·32	− ·65	80 23 22·04			
39 24 20·88	16 51 44·44	+ 3·57	− 0 0·57	·00	39 24 23·88			
						20·35	+ 9 34 16·21	+29 57 55·50
358 35 11·76		− 0·39	+ 2 34·69	− ·05	358 37 46·01			
356 25 53·66	17 27 37·75	+ 1·14	+ 9 50·58	− ·19	356 35 45·19			
						22·72	+52 23 42·66	+29 57 58·40
41 27 0·62		+ 2·62	− 0 34·98	+ ·01	41 26 28·27			
1 41 34·61	17 29 7·49	+ 2·85	+ 0 53·05	− ·02	1 42 30·49			
						17·16	+12 39 7·87	+29 57 58·03
36 37 12·32		− 6·72	−17 29·42	+ ·33	36 19 36·51			
41 50 20·22	17 27 37·75	−10·96	−23 40·02	+ ·45	41 26 29·69			
						22·67	+52 23 42·94	+29 57 59·47
356 22 28·26		+ 6·12	+12 13·96	− ·25	356 35 48·09			
356 29 55·56	17 27 37·75	+ 5·58	+ 5 47·52	− ·11	356 35 48·55			
						22·67	+52 23 42·94	+29 58 0·34
41 28 6·38		−10·88	− 1 27·12	+ 03	41 26 28·41			
1 42 21·66	17 29 7·50	+ 1·04	+ 0 11·96	·00	1 42 34·66			
						17·14	+12 39 8·04	+29 57 57·38
36 20 28·80		+ 5·34	− 0 55·11	+ ·02	36 19 39·05			
39 35 29·20	18 1 24·88	+ 0·60	− 9 24·15	+ ·19	39 26 5·84			
						20·47	+ 9 32 47·13	+29 58 1·67
358 34 32·00		+ 4·30	+ 1 41·43	− ·03	358 36 17·70			

chronometer correction = +2 h. 22 m. 1·56 s. + 0·103 s. per hour
„ „ = +2 24 4·09 + 0·103 „

† 327° in original.

§ 44′ in original.

ALTITUDE OBSERVATIONS. PART 2. OBSERVATIONS AND REDUCTIONS

Date and number	Position of circle	Star	Time by chronometer	Level I.		Level II.		Microscopes: preceding and following divisions					Barometer	Thermometer
									C	D	E	F		
1874			h. m. s.	p.	p.	p.	p.	r.	p.	p.	p.	p.	in.	°
Sept. 30	E	*a* Lyræ	14 18 40·7	+18·4	−18·7	+18·1	−19·9		28·3	20·6	32·3	38·2		
1				+18·0	−19·2	+17·5	−20·1	0	29·0	20·2	36·9	39·1		
	W	„	14 26 49·5	+18·0	−19·2	+17·8	−20·1		44·8	50·6	56·1	72·9	30·08	69·5
				+18·0	−19·2	+18·6	−19·3	3	40·9	48·2	58·7	74·0		
2	W	*a* Lyræ	14 35 45·0	+18·0	−19·1	+18·9	−19·0		...*	51·3	...	73·0	„	„
				+18·2	−19·0	+18·9	−19·0	1	...	52·2	...	73·5		
	E	„	14 38 40·0	+18·0	−19·2	+17·7	−20·3		...	38·1	...	58·1		
				+17·5	−20·0	+17·0	−21·1	0	...†	37·0	...	58·0		
3	W	*a* Pavonis ‡	16 2 44·5	+19·0	−18·3	+20·0	−18·2		45·1	42·3	45·6	58·6		
				+18·6	−18·8	+19·7	−18·5	1	44·1	40·3	47·9	58·3		
	E	„	16 11 2·7	+19·1	−18·5	+19·3	−18·9		33·0	39·2	38·4	59·7	30·033	65·5
				+19·8	−18·0	+20·0	−18·3		30·5	39·2	37·6	60·3		
4	E	*a* Pavonis §	16 21 57·0	+19·0	−18·5	+18·8	−19·4		0·3	10·3	15·9	28·8	„	„
				+19·6	−18·3	+19·0	−19·3	4	0·0	10·3	9·8	29·6		
	W	„	16 29 38·5	+18·6	−19·0	+19·8	−18·3		33·0	20·9	25·8	42·1		
				+19·0	−18·7	+20·0	−18·3	0	30·2	25·8	25·8	41·6		
5	W	*a* Cygni §	16 37 45·0	+18·8	−18·9	+20·0	−18·5		51·4	54·2	50·9	75·5	„	„
				+18·5	−19·0	+20·0	−18·3	1	46·3	56·9	55·8	74·0		
	E	„	16 44 8·0	+18·6	−19·0	+18·7	−19·8		60·0	57·8	58·0	71·6		
				+18·5	−19·0	+18·9	−19·3	4	55·6	57·4	62·9	...		
6	E	*a* Cygni §	16 51 31·7	+19·0	−18·8	+18·7	−19·8		9·0	6·3	8·0	15·9	„	„
				+18·0	−19·2	+18·0	−20·2	2	6·3	7·3	10·0	23·0		
	W	„	16 58 5·7	+17·9	−19·8	+17·9	−20·6		55·3	64·7	59·5	79·7		
				+17·7	−20·1	+18·0	−20·3	0	55·2	65·8	62·8	85·8		
7	W	61[1] Cygni §	17 9 31·0	+17·3	−20·4	+17·1	−21·0		23·6	33·1	28·0	54·5	„	„
				+16·9	−20·8	+17·9	−20·7	3	20·8	35·4	31·3	52·0		
	E	'	17 16 1·0	+17·8	−20·0	+17·3	−21·0		19·5	17·5	35·0	35·2		
				+17·3	−20·1	+17·8	−20·6	1	17·7	19·2	33·0	34·0		
8	E	*a* Gruis §	17 44 55·8	+18·3	−19·5	+19·0	−19·3		54·6	56·0	55·9	74·3	„	„
				+18·4	−19·1	+19·0	−19·3	4	51·1	59·0	60·2	77·6		
	W	„	17 51 44 5	+17·8	−19·9	+18·1	−20·1		9·8	2·7	9·0	21·8		
				+17·5	−20·1	+17·6	−20·6	2	8·3	4·9	11·1	24·0		

* The wire of E broke, so C and E not used. † r′ in original. ‡ Used highest power eye-piece and no dew-cap. Adjusted focus.
§ Highest power eye-piece and n dew-cap.

OF CIRCUM-MERIDIAN ALTITUDES AT PAMPLEMOUSSES. OBSERVER, MR. GILL.

Concluded circle reading	R.A. of star	Corrections for			Meridional		Declination of star	Latitude
		Level	Reduction to meridian	Δ Ref.	Circle reading	Refraction		
° ′ ″	h. m. s.	″	′ ″	″	° ′ ″	″	° ′ ″	° ′ ″
77 55 31·12	18 32 41·50	−1·62	− 9 49·60	+·60	77 45 40·50	92·28	+38 40 14·38	−20 5 36·89
320 13 55·89		−1·58	+ 3 8·40	−·19	320 17 2·52			
320 17 2·58	18 32 41·50	−0·70	+ 0 4·61	·00	320 17 6·49	92·28	+38 40 14·38	−20 5 35·62
77 45 47·58		−2·96	− 0 2·68	·00	77 45 41·94			
56 11 47·73	20 15 44·22	+0·93	− 8 39·99	+·23	56 3 8·90	42·65	−57 8 20·78	−20 5 38·85
341 56 42·10		+1·35	+ 2 26·97	−·07	341 59 10·35			
341 59 13·58	20 15 44·22	+0·39	+ 0 3·70	·00	341 59 17·67	42·65	−57 8 20·78	−20 5 41·15
56 5 30·84		+0·78	− 2 20·04	+·06	56 3 11·64			
314 6 58·15	20 37 10·00	+0·60	+ 0 24·70	−·04	314 7 23·41	120·07	+44 50 9·10	−20 5 36·21
83 55 1·86		−0·69	− 0 7·29	+·01	83 54 53·89			
83 57 10·80	20 37 10·00	−1·18	− 2 14·16	+·20	83 54 55·66	120·07	+44 50 9·10	−20 5 37·64
314 1 6·75		−2·74	+ 6 18·88	−·57	314 7 22·32			
320 48 34·85	21 1 17·37	−4·09	+ 0 20·96	−·02	320 48 51·70	90·97	+38 8 11·28	−20 5 40·01
77 ‖ 16 26·23		−3·35	− 2 50·71	+·17	77 13 32·34			
351 15 0·17	22 0 21·13	−0·80	+18 8·17	−·40	351 33 7·14	29·40	−47 34 8·66	−20 5 37·59
46 37 11·52		−2·87	− 7 58·34	+·17	46 29 10·48			

‖ 87° in original.

ALTITUDE OBSERVATIONS. PART 2. OBSERVATIONS AND REDUCTIONS

Date and number	Position of circle	Star	Time by chronometer	Level I.		Level II.		Microscopes: preceding and following divisions					Barometer	Thermometer
									C	D	E	F		
1874			h. m. s.	p.	p.	p.	p.	r.	p.	p.	p.	p.	in.	°
Sept. 30 (*cont.*)	W	*a* Gruis *	17 59 10·0	+17·9	−19·8	+18·0	−20·1		44·0	34·5	41·5	58·0		
				+17·9	−19·8	+18·5	−19·9	0	41·5	35·1	43·0	59·0		
9	E	,,	18 6 21·0	+18·6	−18·9	+18·9	−19·6		61·7	59·9	60·2	81·2		
				+18·3	−19·2	+19·0	−19·3	2	56·2	63·5	62·5	86·4		
Oct. 14	W	ζ Pegasi	18 42 23·0	+16·7	−20·4	+16·0	−21·9		46·5	48·3	49·5	69·5		
10				+16·5	−20·8	+16·3	−21·3	2	41·5	49·5	52·0	69·8		
	E	,,	18 50 24·0	+16·9	−20·0	+16·9	−20·8		4·9	0·5	6·5	18·0	29·991	65·7
				+17·0	−20·0	+17·6	−20·1	2	5·0	1·2	8·8	14·5		
11	E	γ Piscium *	19 13 15·0	+18·8	−18·3	+18·1	−19·3		51·0	44·6	50·8	59·0	29·998	66·1
				+18·0	−19·0	+18·1	−19·5	1	50·8	53·3	52·0	59·2		
	W	,,	19 26 33·0	+17·0	−20·0	+15·8	−22·0		27·1	32·0	35·0	50·0	29·996	65·8
				+17·0	−20·5	+16·1	−21·5	4	26·8	33·0	36·5	51·0		
12	E	β Hydri *	19 42 12·0	+17·3	−18·9	+19·0	−18·9		15·3	29·4	23·5	34·8		
				+18·5	−18·6	+19·0	−18·6	1	13·0	29·0	23·1	36·0		
	W	,,	19 51 16·0	+17·7	−19·8	+18·2	−19·5		44·9	47·0	48·9	64·2	29·999	65·8
				+17·5	−19·6	+18·0	−19·6	4	45·7	50·3	53·9	63·5		
13	W	β Hydri *	19 59 57·5	+17·7	−19·7	+18·1	−19·6		54·5	53·9	58·4	68·8	[30·001]	[65·9]
				+17·5	−19·7	+18·4	−19·4	4	53·4	56·1	60·6	70·5		
	E	,,	20 6 51·0	+18·1	−19·2	+18·3	−19·0		29·0	34·7	27·0	48·1		
				+18·5	−18·6	+19·3	−18·4	0	24·2	37·3	30·2	52·2		
14	E	β Hydri *	20 13 29·0	+18·5	−18·6	+18·8	−19·0		41·3	53·3	42·5	65·0		
				+18·7	−18·3	+19·0	−18·6	2	39·0	51·9	47·1	67·0		
	W	,,	20 20 53·0	+18·8	−18·2	+19·0	−18·8		50·3	48·1	54·8	63·0	30·002	65·9
				+18·0	−19·1	+18·8	−19·0	2	49·7	50·9	51·0	68·0		
Oct. 18	E	*a* Gruis †	17 50 16·0	+18·3	−18·7	+18·9	−19·0		16·0	17·9	22·9	37·0	[30·004]	[66·8]
15				+18·8	−18·5	+19·3	−18·4	2	12·7	20·0	18·8	36·3		
	W	,,	17 57 31·0	+17·5	−19·7	+17·0	−20·6		17·5	11·8	14·6	27·3		
				+17·5	−19·6	+18·3	−19·5	1	15·5	13·5	18·0	33·5		
16	W	*a* Gruis †	18 3 25·0	+18·1	−19·0	+18·9	−19·0		67·2	59·8	67·7	79·9		
				+17·5	−19·6	+18·3	−19·3	3	64·8	62·9	70·0	79·0		
	E	,,	18 10 9·0	+18·2	−18·6	+19·9	−17·8		54·2	57·7	57·1	75·2		
				+18·1	−18·8	+19·0	−18·5	1	51·0	59·8	61·8	74·3		

* Highest eye-piece and no dew-cap.

† Diagonal eye-piece and dew-cap used.

OF CIRCUM-MERIDIAN ALTITUDES AT PAMPLEMOUSSES. OBSERVER, MR. GILL (*continued*).

Concluded circle reading	R.A. of star	Corrections for			Meridional		Declination of star	Latitude
		Level	Reduction to meridian	△ Ref.	Circle reading	Refraction		
° ′ ″	h. m. s.	″	′ ″	″	° ′ ″	″	° ′ ″	° ′ ″
46 30 44·62	22 0 21·13	−2·18	− 1 34·15	+ ·03	46 29 8·32			
						29·40	−47 34 8·66	−20 5 40·06
351 33 6·20		−0·66	+ 0 4·37	·00	351 33 9·91			
348 42 53·32	22 35 13·27	−5·49	+ 2 26·75	− ·06	348 45 14·52			
						32·94	+10 10 45·34	−20 5 37·43
49 17 7·45		−3·70	− 0 9·57	·00	49 16 54·18			
41 51 52·91	23 10 40·91	−0·82	− 9 33·80	+ ·19	41 42 18·48			
						23·60	+ 2 35 57·33	−20 5 37·23
356 19 36·08		−5·16	+ 0 25·66	− ·01	356 19 56·57			
320 51 25·38	0 19 16·41	−0·46	+19 17·18	−1·09	321 10 41·01			
						89·54	−77 57 41·38	−20 5 38·03
77 4 51·34		−2·17	−13 1·29	+ ·74	76 51 48·62			
76 59 58·90	0 19 16·41	−2·07	− 8 9·37	+ ·47	76 51 47·93			
						89·53	−77 57 41·38	−20 5 38·40
321 5 35·74		−0·36	+ 5 5·95	− ·29	321 10 41·04			
321 7 50·82	0 19 16·41	+0·16	+ 2 49·78	− ·16	321 10 40·60			
						89·53	−77 57 41·38	−20 5 37·40
76 52 54·37		−0·17	− 1 4·76	+ ·06	76 51 49·50			
351 7 22·65	22 0 20·85	+0·16	+25 26·61	− ·53	351 32 48·89			
						29·29	−47 34 11·64	−20 5 40·16
46 41 19·46		−2·68	−12 24·40	+ ·26	46 28 53·26			
46 34 8·33	22 0 20·85	−1·31	− 5 10·59	+ ·12	46 28 56·55			
						29·30	−47 34 11·64	−20 5 36·58
351 32 1·45		+0·28	+ 0 43·32	− ·02	351 32 45·03			

ALTITUDE OBSERVATIONS. PART 2. OBSERVATIONS AND REDUCTIONS

Date and number	Position of circle	Star	Time by chronometer	Level I.	Level II.	Microscopes: preceding and following divisions				Barometer	Thermometer
						C	D	E	F		
1874			h. m. s.	p. p.	p. p.	r. p.	p.	p.	p.	in.	°
Oct. 18	E	*a* Gruis *	18 15 42·0	+18·0 −18·8	+19·0 −18·6	36·2	36·2	36·0	52·1		
(*cont.*)				+18·0 −19·0	+19·0 −18·6	2 30·6	37·5	38·8	56·5		
17	W	„	18 21 25·0	+18·5 −18·5	+19·6 −18·2	14·5	13·8	7·5	21·9	30·004	66·8
				+18·5 −18·5	+20·0 −17·6	1 12·0	11·8	12·0	24·0		
18	W	ζ Pegasi *	18 32 9·0	+18·3 −18·8	+20·0 −17·9	47·4	53·6	53·6	75·7	[30·006]	[66·4]
				+18·5 −18·6	+19·8 −18·0	2 47·2	57·5	56·1	74·8		
	E	„	18 37 12·3	+18·5 −18·5	+19·0 −18·5	60·8	54·5	59·6	70·0		
				+18·5 −18·2	+18·3 −19·2	4 61·0	54·0	61·0	70·9		
19	E	ζ Pegasi *	18 44 19·5	+18·6 −18·2	+18·2 −19·2	60·0	51·3	54·9	67·0		
				+17·8 −19·5	+18·8 −19·0	2 58·2	53·8	60·8	67·3		
	W	„	18 50 0·0	+17·8 −19·1	+18·2 −19·5	52·0	58·0	56·0	73·1	30·007	66·2
				+18·0 −19·0	+18·7 −19·1	4 46·5	59·2	59·0	76·4		
20	W	ι Piscium *	19 37 20·0	+16·9 −20·5	+18·0 −20·1	25·0	32·8	26·3	47·0		
				+16·9 −21·5	+19·0 −19·0	1 25·0	28·6	28·4	47·0		
	E	„	19 47 40·0	+18·1 −19·1	+19·0 −19·0	55·7	48·0	54·2	70·5	30·010	66·5
				+17·0 −20·1	+19·0 −19·0	2 51·9	52·0	58·3	66·8		

* Diagonal eye-piece and dew-cap used.

h. m.
1874, Sept. 30, at 19 0 by chronometer 41,
„ Oct. 14 „ 18 0 „ „
„ Oct. 18 „ 19 0 „ „

ALTITUDE OBSERVATIONS. PART 3. OBSERVATIONS AND

Date, 1874	Position of circle	Star	Time by chronometer	Level I.	Level II.	Microscopes: preceding and following divisions				Barometer	Thermometer
						C	D	E	F		
			h. m. s.	p. p.	p. p.	r. p.	p.	p.	p.	in.	°
Dec. 23	E	σ Arietis	2 37 3·8	+17·3 −19·0	+20·0 −16·7	46·6	44·6	32·4	36·6		
				+17·1 −18·9	+19·2 −17·5	0 44·6	42·1	32·2	36·2		
	W	„	2 59 46·3	... ...	... ...	4·7	16·2	1·0	8·4		
				+11·1 −25·1	+11·9 −24·9	3 2·9	17·6	3·3	8·6		
	W	*o* Tauri	3 13 42·0	+10·4 −25·8	+11·3 −25·6	29·4	32·7	10·5	35·2		
				+10·2 −25·9	+11·2 −25·4	2 23·6	36·7	14·3	30·2		
	E	„	3 22 55·0	+19·8 −16·1	+23·1 −13·3	35·4	25·1	18·1	26·2		
				+19·8 −16·3	+23·0 −13·4	0 31·2	32·5	16·8	25·0		
	E	*a* Tauri	4 24 31·5	+18·3 −18·1	+21·4 −15·3	6·1	2·3	56·7 ‡	4·8		
				... ...	... ...	0 4·2	5·2	1·2	2·9		
	W	„	4 33 3·5	+15·1 −20·9	+15·2 −21·7	40·4	55·4	37·8	47·8	30·01	77·5
				+15·0 −20·4	+15·1 −21·5	2 37·3	52·8	35·9	47·2		

‡ The first and fourth observations are by Mr. Burton, the second

OF CIRCUM-MERIDIAN ALTITUDES AT PAMPLEMOUSSES. OBSERVER, MR. GILL (*continued*).

Concluded circle reading	R.A. of star	Correction for			Meridional		Declination of star	Latitude
		Level	Reduction to meridian	△ Ref.	Circle reading	Refraction		
° ′ ″	h. m. s.	″	′ ″	″	° ′ ″	″	° ′ ″	° ′ ″
351 32 40·39	22 0 20·85	−0·42	+ 0 6·41	·00	351 32 46·38	29·29	−47 34 11·64	−20 5 38·61
46 31 14·81		+0·96	− 2 21·97	+ ·06	46 28 53·86			
348 27 58·13	22 35 13·24	+0·78	+17 1·21	− ·39	348 44 59·73	32·91	+10 10 45·50	−20 5 37·02
49 25 1·21		0·00	− 8 22·45	+ ·19	49 16 38·95			
49 17 59·01	22 35 13·24	−0·75	− 1 19·75	+ ·03	49 16 38·54	32·92	+10 10 45·50	−20 5 35·76
348 44 † 59·72		−1·22	+ 0 3·37	·00	348 45 1·87			
353 51 32·40	23 33 31·27	−3·34	+ 7 13·15	− ·15	353 58 42·06	26·34	+ 4 56 56·14	−20 5 36·83
44 2 57·19		−1·40	− 0 0·47	·00	44 2 55·32			

† 29′ in original.

chronometer correction = +3 h. 55 m. 16·34 s. − 0·195 s. per hour.
" " = +3 46 27·24 − 0·168 "
" " = +3 46 11·25 − 0·168 "

REDUCTIONS OF CIRCUM-MERIDIAN ALTITUDES AT BELMONT.‡

Concluded circle reading	R.A. of star	Correction for			Meridional		Declination of star	Latitude
		Level	Reduction to meridian	△ Ref.	Circle reading	Refraction		
° ′ ″	h. m. s.	″	′ ″	″	° ′ ″	″	° ′ ″	° ′ ″
53 40 38·96	2 44 35·87	+ 0·06	− 2 57·42	+ ·07	53 37 41·67	38·08	+14 14 3·04	−20 2 58·68
344 13 7·76		−16·16	+12 3·10	− ·31	344 24 54·39			
350 22 § 26·61	3 18 5·79	−17·84	+ 1 12·93	− ·03	350 23 21·67	30·13	+ 8 35 20·48	−20 3 1·15
47 40 26·33		+ 7·36	− 1 29·05	+ ·03	47 39 4·67			
55 20 3·37	4 28 45·70	+ 3·22	− 0 53·12	+ ·02	55 19 13·49	40·53	+16 15 29·99	−20 3 0·76
342 42 44·42		− 7·09	+ 0 55·75	− ·02	342 43 33·06			

and third by Lieutenant Neate, and the remainder by Dr. Pechüle.

§ 7′ in original.

ALTITUDE OBSERVATIONS. PART 3. OBSERVATIONS AND REDUCTIONS

Date, 1874	Position of circle	Star	Time by chronometer	Level I.		Level II.		Microscopes: preceding and following divisions					Barometer	Thermometer
									C	D	E	F		
			h. m. s.	p.	p.	p.	p.	r.	p.	p.	p.	p.	in.	°
Dec. 23 (*cont.*)	E	*a* Columbæ	5 35 42·9	...	...	...	...		65·1	67·9	56·1	64·5		
				+14·5	−21·6 *	+14·7	−22·1 †	o	64·7	69·6	60·1	65·2		
	W	„	5 46 35·0	...	...	...	...		12·2	5·6	58·1 !	1·0	30·074	
				+16·7	−19·7	+18·2	−18·6	o	10·6	7·3	59·1 !	0·4		
Dec. 29	W	37 Tauri	5 27 18·0	+16·1	−21·1	+16·0	−20·8		15·8	36·0	20·8	28·3		
				+14·8	−21·2	+17·2	−19·7	2	18·2	36·6	23·8	28·8		
	E	„	5 40 52·0	+15·2	−21·0	+16·3	−20·3		... ‡	...	...	...		
				+15·1	−21·0	+17·2	−19·3	4	40·2	43·4	29·8	31·3		
	E	λ Pictoris §	6 15 15·0	+14·3	−21·9	+15·7	−21·0		35·0	50·5	35·8	45·8		
				+13·9	−22·2	+15·8	−20·9	1	36·6	57·5	31·5	44·0		
	W	„	6 27 18·0	+15·2	−20·0	+16·3	−20·3		8·9	9·4	...	...	29·978	78·8 ‖
				+15·1	−21·0	+17·7	−19·1	o	12·2	7·3	54·4 !	1·5		
Dec. 30	E	Lac. 1092	4 45 12·0	+14·0	−22·1	+14·3	−22·2		36·8	59·1	45·4	44·4		
				+14·0	−22·1	+13·9	−22·7 ¶	1	39·2	58·5	41·7	45·6		
	W	„	5 1 49·0	+16·9	−19·2	+18·9	−17·7		36·4	40·4	33·7	27·7		
				+16·6	−19·5	+18·6	−18·0	2	37·2	38·7	31·9	26·4		
	W	*η* Tauri	5 14 43·0	+16·0	−20·1	+17·3	−19·2		46·9	67·0	52·3	56·0		
				+15·3	−20·8	+17·4	−19·1	o	47·6	66·0	52·7	55·6		
	E	27 Tauri	5 26 25·0 **	+14·3	−21·7	+15·1	−21·4		53·6	58·1	47·8	42·2		
				+14·5	−21·7	+15·3	−21·3	3	53·3	56·2	48·5	42·9		
	E	*a* Reticuli	5 40 55·0	+14·3	−21·7	+15·6	−21·0		2·4	21·3	6·1	7·8	29·998	79·2
				+14·3	−21·8	+14·8	−21·7	2	3·0	21·3	4·8	8·4		
	W	„	5 51 50·0	+16·0	−20·2	+17·5	−19·1		31·2	34·7	22·7	16·9		
				+15·8	−20·2	+18·1	−18·3	o	31·3	30·8	23·0	17·2		
	W	*τ* Tauri	6 2 30·0	+16·0	−20·2	+17·2	−19·2		35·4	...††	40·7	...	30·008	79·2
				+15·8	−20·2	+17·2	−19·3	4	37·3	57·3	39·9	39·2		
	E	„	6 14 32·0	+15·2	−21·0	+15·6	−21·0		13·1	13·2	8·0	1·4		
				+15·1	−21·1	+15·6	−21·0	3	16·2	12·4	5·0	3·2		

	h.	m.	
1874, Dec. 23, at	3	52	chronometer time,
„ „ „ „	6	1	„ „
„ „ 29 „	4	2·05	„ „
„ „ 30 „	4	2·27	„ „

* 8·4 in original. † 7·9 in original. By reading from the wrong end of the scale the observer had given the complements of 30·0.

‡ Corrections for runs on December 29: C−1″·95, D−1″·83, E+0″·65, F+0″·65; in each case on 5′.

§ An observation of *θ* Doradûs attempted on this day has been rejected, as the readings cannot be reconciled with the position of that or any known star in the neighbourhood.

‖ At 8h chronometer time, thermometer =78°·0. ¶ +18·9−17·7 in original.

** The original note-book gives 5h 23m 25s as the epoch of a second observation of *η* Tauri; but this leads to inadmissible results, nor does an alteration of the time by any number of full minutes reconcile the readings with the place of that star. The assumption that 27 Tauri was taken 3m later brings everything into accordance, besides making the elapsed time between the two settings of the usual duration.

†† Corrections for runs on December 30: D+1″·41, F−0″·41; in each case on 5′.

OF CIRCUM-MERIDIAN ALTITUDES AT BELMONT (*continued*).

Concluded circle reading	R.A. of star	Correction for			Meridional		Declination of star	Latitude
		Level	Reduction to meridian	△ Ref.	Circle reading	Refraction		
° ′ ″	h. m. s.	″	′ ″	″	° ′ ″	″	° ′ ″	° ′ ″
4 56 4·59	5 35 8·74	−8·60	+ 0 2·21	·00	4 55 58·20	13·88	−34 8 25·59	−20 2 58·23
33 20 4·36		−2·26	−13 37·17	+ ·23	33 6 25·16			
337 12 26·08	3 57 18·99	−5·75	+ 2 21·45	− ·07	337 14 41·71	49·10	+21 44 27·54	−20 2 56·60
60 49 35·58		−5·54	− 1 38·31	+ ·05	60 47 51·78			
348 21 42·09	4 39 36·36	−8·07	+ 0 6·06	·00	348 21 40·08	32·60	−50 43 3·06	−20 2 56·09
49 45 3·83		−5·03	− 4 10·07	+ ·09	49 40 48·82			
331 41 46·32	3 16 37·35	−9·76	+ 0 23·81	− ·01	331 42 0·36	59·56	−67 23 5·80	−20 2 55·92
66 22 34·06		−1·32	− 2 11·82	+ ·08	66 20 21·00			
335 15 55·50	3 40 3·90	−4·20	+ 0 3·44	·00	335 15 54·74	52·61	+23 43 10·09	−20 2 57·38
62 48 50·40	3 41 44·44	−8·10	− 5 8·67	+ ·16	62 43 33·79	52·52	+23 40 19·34	
336 17 9·38	4 12 51·94	−8·21	+ 0 35·46	− ·02	336 17 36·61	50·76	−62 47 17·98	−20 2 53·90
61 45 25·66		−3·40	− 0 39·04	+ ·02	61 44 43·24			
336 14 43·43	4 34 45·39	−3·98	+ 1 18·28	− ·04	336 15 57·69	50·82	+22 43 3·49	−20 2 57·11
61 48 9·02		−6·76	− 1 45·06	+ ·05	61 46 17·25			

	h.	m.	s.	
chronometer correction =	+0	0	1·2.	Chronometer 'Walker 174.'
" " =	+0	0	1·5	" "
" " =	−1	37	38·27 + 9ˢ·93 per hour.	Chronometer No. 31.
" " =	−1	33	39·88 + 9ˢ·93 " "	" "

ALTITUDE OBSERVATIONS. PART 4. OBSERVATIONS AND REDUCTIONS

Date, 1875	Position of circle	Star	Time by chronometer	Level I.	Level II.	Microscopes: preceding and following divisions				Barometer	Thermometer
						C	D	E	F		
			h. m. s.	p. p.	p. p.	r. p.	p.	p.	p.	in.	
Mar. 15	E	β Cancri	8 19* 54·1	+17·7† −21·5	+18·9‡ −21·3	62·2	84·8	75·0	53·8	[29·9]	[56°·1]
				... ...	... ...	1 58·8	86·8	78·5	53·0		
	W	„	8 33§ 6·0	+19·6 −19·3	+20·1 −19·5	47·0	59·5	54·5	30·1		
				+19·8 −19·5	+20·0 −19·8	4 47·0	59·0	56·0	29·0		
	W	o Ursæ maj.	8 43 24·0	+20·0 −18·9	+20·1 −19·5	11·2	37·6	29·1	9·0		[57·0]
				+20·1 −18·8	+20·5 −19·2	0 9·3	39·9	32·0	9·4		
	E	„	8 56 47·0	+20·2 −18·8	+22·1 −17·5	12·2	20·0	16·1	54·1 !		
				... ...	... ...	0 10·2	23·0	14·0	53·0 !		
	E	ι Ursæ maj.	9 8 23·0	+18·5‖ −19·5	+21·0 −18·9	47·6	59·0	56·4	31·2		[56·2]
				+19·1 −20·0	+20·6 −19·1	1 46·1	61·0	58·2	30·5		
	W	„	9 19 13·0	+19·2 −19·8	+20·0 −19·9	66·8	86·8	79·0	59·0		
				+19·6 −19·3	+20·1 −19·6	1 64·0	89·0	80·2	58·7		
	W	θ Hydræ	9 28 53·0	+19·8 −19·1	+20·5 −19·1	42·2	52·2	46·0	25·8		[56·5]
				+20·3 −18·6	+21·1 −18·6	2 41·0	55·5	48·8	25·2		
	E	„	9 38 33·8	+19·0 −20·0	+19·0 −19·9	51·0	79·0	70·0	51·8		
				+17·8 −21·2	+18·8 −21·1	3 48·6	80·5	72·2	50·5		

NOTE.—Owing to the loss of the meteorological instruments by theft, the height of the barometer at Alexandria is give a fair approximation to the temperature. From the whole of the level readings at the various stations, as well as from the bubbles—

$$t = 380°{\cdot}0$$

Or, $$t = 323°{\cdot}5$$

These formulæ have been used for computing the temperatures at Alexandria. They fairly represent all the observations which kept the circle levels at a temperature above that of the thermometer outside.

After the reductions were completed we learnt, through the kindness of Monsieur A. Pirona, Directeur de la Station barometer stood at 764·0 mm. and the thermometer at 15° 2 Cels., or 30·08 in. and 59°·4 Fahr. The effect of the difference 1875, Mar. 15, at $10^h\ 13^m$ by chronometer 41,

* 20^m in original, for one minute $\Delta z = 83''{\cdot}86$.

† 15·7 in original.

‡ 13·9 in original. The level readings, circle West, give $I = 39{\cdot}1$ and $II = 39{\cdot}7$; applying these to the *minus* readings given above, the resulting (hypothetical) *plus* readings are +17·6 and +18·4, whence we may safely conclude that errors of two and five parts respectively were made in the *minus* readings. Possibly, however, 15·7 may be merely a transposition of 17·5. The changes made practically amount to discarding the *minus* readings and adopting the known lengths of the bubbles.

§ 32^m in original, for one minute $\Delta z = 25''{\cdot}66$.

‖ Taken at 19·5 for computing temperature: compare length of bubble.

OF CIRCUM-MERIDIAN ALTITUDES AT ALEXANDRIA. OBSERVER, MR. GILL.

Concluded circle reading	R.A. of star	Correction for			Meridional		Declination of star	Latitude
		Level	Reduction to meridian	△ Ref.	Circle reading	Refraction		
357° 17′ 9″·05	h. m. s. 8 9 45·27	−3″·82	+7′ 14″·00	−″·15	357° 24′ 19″·08	″ 22·75	° ′ ″ + 9 34 10·23	° ′ ″ +31 11 52·23
40 39 47·75		+0·40	−0 50·59	+ ·02	40 38 57·58			
349 5 22·51	8 19 54·73	+1·30	+0 19·89	− ·01	349 5 43·69	32·96	+61 8 15·78	+31 11 48·86
49 5 10·04		+3·29	−7 41·90	+ ·17	48 57 31·60			
36¶ 21 48·76	8 50 40·69	+0·26	−0 19·46	+ ·01	36 21 29·57	17·90	+48 32 0·26	+31 11 50·11
1 37 12·88		+0·04	+4 32·24	− ·09	1 41 45·07			
47 22 41·98	9 7 53·03	+1·81	−0 3·61	·00	47 22 40·18	30·93	+ 2 50 22·29	+31 11 51·64
350 34 2·87		−2·32	+6 42·93	− ·15	350 40 43·33			

assumed to be 29^{in}·9. The tubes of the circle levels being hermetically closed, the lengths of the bubbles can be used to some experiments made at Dunecht, we find that if t is the temperature in degrees Fahrenheit, and l I. and l II. the lengths of

$-8{\cdot}33\ l$ I.
$-6{\cdot}69\ l$ II.

except those at Pamplemousses, where the error is about 4°. This deviation was probably due to the closeness of the dome,

Météorologique de l'imp. et roy. Institut central à Vienne at Alexandria, that at 9 P.M. $= 8^h\ 33^m$ sid. time, March 15, 1875, the between these quantities and those adopted is practically inappreciable, as it does not affect the latitude to the extent of 0″·02. chronometer correction $= -0^h\ 19^m\ 59^s{\cdot}20 + 0^s{\cdot}097$ per hour.

¶ 37° 35 in original.

Deduction of the Final Latitudes.

On comparing the results at any of the stations derived from stars north and stars south of the zenith there is in every case a decidedly marked difference. This difference has not the same sign at all the stations, nor is it easy to see whence it arises. It cannot well be caused by an imperfect knowledge of the refraction due to inapplicability of the tables or want of precision in the meteorological data, because it is quite as strongly marked for stars near the zenith as for those nearer the horizon. We must therefore look to flexure for a solution of the difficulty. It has already been pointed out that the long diagonal eye-piece which alone can be used for observations near the zenith, projecting, as it does, $3\frac{1}{2}$ inches from the axis of the tube, and weighing about $3\frac{1}{2}$ ounces, is most likely to produce appreciable flexure. The amount of this will probably depend on the degree of firmness with which the draw-tube is clamped, as well as on the zenith distance. In this case it would be liable to change whenever the draw-tube clamp was loosened for the purpose of adjusting the focus. It should, too, be borne in mind that whenever the instrument is turned half round to observe an object in the second position, the diagonal eye-piece, as a rule, is rotated through 180° with regard to the tube. It is true that for a star very near the zenith this rotation of the eye-piece may be dispensed with, but on reversal the observer must pass round to the other side of the instrument. It is also evident that for these zenith observations the eye-piece may be turned either towards the north or south for a given position of the circle. But it is also equally evident that the flexure caused by the weight of the eye-piece excentrically placed will not be the same in each case. Beyond these peculiarities the weight of the diagonal eye-piece is sufficient under favouring circumstances to turn the telescope when unclamped. The addition of a dew-cap at the object-glass end restores the equilibrium, but not without further complicating the problem of determining the effect of flexure. On consideration it will be seen that one probable result of the use of an eye-piece such as that here described will be to destroy the continuity of the observations at the zenith.

For most of the observations it is not stated what eye-piece was employed, or whether the dew-cap was used or not. At Pamplemousses, however, where these particulars are given for nearly all the observations, the southern stars give a markedly greater southern latitude than the northern ones, irrespective of the apparatus used with the telescope. On the contrary, at Belmont, where no such particulars are given, the northern stars give the more southern latitude in an equally decided degree. Under these circumstances it would be hopeless, from the meagre materials at our disposal, to attempt the determination of a general law of flexure applicable to the instrument at every station.

A much safer and simpler plan is to combine stars on each side of the zenith into pairs, as nearly as may be, of the same zenith distance. With this object in view it will be best to depart from the chronological order and commence with Pamplemousses, as the station at which the greatest number of observations were made. The results may be classed as follows :—

	Resulting latitude	Number of observations
1*a*. From stars south of the zenith, observed with highest eye-piece and no dew-cap	−20 5 38·78	7
1*b*. From stars north of the zenith, otherwise as in 1*a*	−20 5 37·77	4
2*a*. From stars south of the zenith, observed with diagonal eye-piece and dew-cap	−20 5 38·45	3
2*b*. From stars north of the zenith, otherwise as in 2*a*	−20 5 36·54	3
3. From stars north of the zenith; no particulars regarding eye-piece or dew-cap	−20 5 36·65	3

These results are scarcely more discordant than might be expected from the size of the instrument, but, as has already been mentioned, the southern stars agree in giving a more southern latitude than the northern ones. If, however, we combine the results from pairs of stars north and south of the zenith, taken in the order of their zenith distances,[1] we get the following latitudes:—

Rotation numbers of observations	Latitude derived from pairs of stars at nearly equal zenith distances, north and south
11, 8	$\phi = -20^\circ\ 5'\ 37''{\cdot}41$
20, 9	38·44
10, 15	38·80
18, 16	36·80
19, 17	37·18
7, 3	39·43
1, 4	39·02
2, 12	36·82
5, 13	37·30
6, 14	37·52
Mean	$= -20\ 5\ 37{\cdot}87 \pm 0''{\cdot}21$

The probable error of one of these results is $\pm 0''{\cdot}649$, or of a single observation $\pm 0''{\cdot}918$.

All traces of systematic discordance have disappeared. The five pairs nearest the zenith give $37''{\cdot}73$ as the seconds of the latitude, while the remaining five yield $38''{\cdot}02$; values so nearly accordant as to show that a small difference in zenith distance does not materially affect the result; hence no serious error is likely to arise from the fact that the mean zenith distance of the northern stars is $44^\circ{\cdot}4$, while that of the southern ones is but $38^\circ{\cdot}5$.

To see in how far the probable error arrived at for the above result is trustworthy, the following course may be taken. At Suez and Pamplemousses several stars were observed more than once; by comparing the results it is found that the probable error of a single observation is $\pm 0''{\cdot}770$. But this is merely the probable error of observation, and is not affected by the systematic errors of division or the probable errors of the declinations. According to the Coast Survey Catalogue, the declinations of the stars used are uncertain to the amount of about $\pm 0''{\cdot}21$. Combining these values, the probable error of a latitude, based on a single observation, but free from systematic division-error and flexure, would be $\pm 0''{\cdot}798$. This leaves the very moderate quantity of

$$\sqrt{0{\cdot}918^2 - 0{\cdot}798^2} = \pm 0''{\cdot}454$$

[1] Whenever an object was observed more than once the observations are combined in the order in which they were made. This is done to prevent any other than an accidental correction of errors apart from flexure.

to cover uncompensated flexure, uncertainty of refraction, and systematic errors of division for a single observation.[1] We may therefore adopt as the resulting latitude of Pamplemousses Observatory (middle of the transit piers)

$$\phi = -20^\circ\ 5'\ 37''\cdot87 \pm 0''\cdot21,$$

with a fair degree of confidence that the real error does not much exceed the theoretical one.

For the remaining stations it will be sufficient to take the mean of the results from stars north and stars south of the zenith, computing the probable error from the outstanding residuals after correction of the single results for half the difference between northern and southern stars. In this way we obtain :—

Latitude of Suez (site defined on p. 2) . . . $= +29^\circ\ 57'\ 59''\cdot05 \pm 0''\cdot49$

Latitude of Belmont : as far as these observations are concerned we have

Latitude of Belmont (altazimuth tent)		-20°	$2'$	$56''\cdot93 \pm 0''\cdot37$ [2]
Reduction to centre of transit pier	= 149·0 feet			$-1''\cdot48$
Latitude of Belmont transit pier from circum-meridian altitudes only .		-20	2	$58''\cdot41 \pm 0''\cdot37$

And lastly :—

Latitude of Alexandria (roof of the Hôtel de l'Europe) . $+31^\circ\ 11'\ 50''\cdot71 \pm 0''\cdot23$

The Latitude of Aden.

The latitude of this station was obligingly determined by the Dutch Transit of Venus party under Professor J. A. C. Oudemans, to whom we are indebted for the following particulars :—

Aden : Circus of the Steamboat Pier.

1874, Aug. 11	Sun	$\delta = +15^\circ\cdot3$	$\phi = +12^\circ$	$47'$	$19''\cdot8$
„ „	α Cygni	+44·8			18·7
„ „	μ Sagittarii	−21·1			18·9
„ 15	Antares	−26·2			21·3
	Mean : . . .		+12	47	19·7
	Reduction to Lord Lindsay's Station				−2·4
	Latitude of Lord Lindsay's Station . .		$+12^\circ$	$47'$	$17''\cdot3$

The reduction is based on the determination that the last-named station bore from the point of observation at the Steamboat Pier 51° 56′ 31″ West of South, distant 120·10 meters, or South 2″·41 and West 3″·14. The erroneous value for ϕ on page 198 evidently arose from applying the reduction from one station to the other with the wrong sign.

[1] The very slight increase of the probable error of an observation, due to the introduction of the uncertainty of a star's declination, shows that the declinations are practically perfect for the determination of latitudes with portable instruments.

[2] In computing this value, the mean of the three northern stars employed on December 23 has been considered as a single observation, balancing α Columbæ to the south. This is the more admissible as the levels and zenith-points are unusually discordant on this day. Indeed at all times it was very difficult to read the levels satisfactorily, mistakes of 5 p. in particular being very liable to occur, as the figures are somewhat indistinct, and not always opposite the divisions.

CHAPTER XXI.

DETERMINATION OF THE LATITUDE OF BELMONT BY OBSERVATIONS IN THE PRIME VERTICAL.

THE reversing transit instrument used at Belmont for finding the time and observing moon culminations is provided with two pairs of Y's at right angles to each other. These Y's have independent adjustments in azimuth, so that while one pair is adjusted for meridional transits the other can be regulated for observations in the prime vertical. This arrangement affords the considerable advantage that the error and rate of the timekeeper, and also the intervals of the wires, can be found with great facility by the usual methods in the meridian, thus permitting the observations in the prime vertical to be devoted exclusively to the determination of the latitudes.

It is true that in latitudes below 45° the method loses some of its precision, from the errors in the tabulated declinations of the stars appearing in an exaggerated form in the results for latitude. For if ϕ is the latitude, δ the declination of a star, and t its hour angle in the prime vertical, we have the fundamental relation

$$\tan \phi = \tan \delta \sec t;$$

whence the equation

$$d\phi = \frac{\sin 2\phi}{\sin 2\delta} \cdot d\delta,$$

in which the coefficient of $d\delta$ is always greater than unity for ϕ less than 45°. However, in the case of μ Hydræ, the most unfavourable star used at Belmont, the coefficient of $d\delta$ is but 1·20. For 54 Eridani it is but 1·01.[1]

In low latitudes, on the other hand, an error in the observed hour angle t becomes less injurious, owing to the smallness of $\frac{1}{2} \sin 2\phi$ in the equation

$$d\phi = \tfrac{1}{2} \sin 2\phi \tan t \cdot dt.$$

At Belmont the average value of t was 25° 58′, which, with an error of ±0ˢ·2 in t, gives ±0″·47 for $d\phi$.

On the whole, therefore, there was no doubt that the method was well worth a trial, particularly as there was no want of well-determined stars within the somewhat narrow zone available.

[1] If $\phi = \pm(45° + n)$, where n is positive, it is evident that for all stars in the zone between $\delta = \pm(45° - n)$ and $\delta = \pm(45° + n)$, the coefficient $\frac{\sin 2\phi}{\sin 2\delta}$ cannot exceed unity, and that it is a minimum for $\delta = \pm 45°$.

A complete description of the reversing transit instrument will be given in the account of the Belmont time determinations; it is therefore only necessary to mention here a few particulars that more immediately affect the observations under consideration.

The telescope of four inches aperture is at one end of the axis outside the stand, and outside it again is a small setting circle with a level. If the vernier is adjusted to the reversed setting after the instrument has been set in the first position, the process of reversing and setting can be effected in twenty or thirty seconds. The axis level can remain in position during the observations, and also while the instrument is being reversed.

As any error in the adopted level corrections enters into the result with its full value, the inclination was determined with extreme care, sometimes by reversing the level with the instrument, and sometimes by also reversing the level on the axis in both positions of the telescope. The level is an exceedingly fine one, completely enclosed in a glass cell; one part of its scale=0″·9871±0″·0031. The adopted equatorial wire intervals from D III. are:—

	s.		s.		s.		s.		s.		s.
A I.	55·899	B I.	32·997	C I.	16·828	D I.	6·156	...	...	G I.	46·310
A II.	53·437	...	...	C II.	15·645	D II.	4·807	E II.	13·284	G II.	48·752
A III.	50·976	B III.	28·135	C III.	14·434	D III.	0·000	E III.	14·434	G III.	51·139
A IV.	48·779	B IV.	25·682	C IV.	13·202	D IV.	3·708	...	...	G IV.	53·388
A V.	46·290	B V.	23·359	C V.	11·934	D V.	4·930	E V.	16·911	G V.	55·949

The missing wires, including the whole of group F, were broken by brass cuttings falling down the tube.

As the instrument was also used in the meridian, it seems desirable to write down the formulæ involved in the discussion of the observations in the prime vertical in a form as nearly analogous as may be to that used for meridional observations. In particular, it is convenient to hold fast to those signs and definitions of the corrections for level, azimuth, and collimation that have obtained a general acceptance in ordinary transit observations for time. For a star at upper culmination south of the zenith we give these corrections the signs with which they must be applied to the time of passage over the middle wire to get the time of meridional transit. These signs are all positive when the prolongation of the axis of rotation towards the west cuts the sphere of the heavens in a point Q, the altitude of which is b, the azimuth $90°-k$, the declination n, and the hour angle $90°-m$, and when, for tube east, the distance between Q and S, the star on the middle wire, is $90°+c$. The azimuth and the hour angle are both counted from the southern part of the meridian round by the west in the usual manner. Suppose now the western Y turned to the north and that the prolongation of the axis of rotation towards the north cuts the sphere of the heavens in a point Q_1, the coordinates of this point[1] will be: b=altitude; $180-k$=azimuth, so that k is positive when west of north; n=declination; $180°-m$=hour angle. If P is the pole of the heavens and Z the zenith, in the triangle PZQ_1 we have, $PZ=90°-\phi$, $PQ_1=90°-n$, $ZQ_1=90°-b$, angle $PZQ_1=k$, and angle $ZPQ_1=180°-m$, between which exist the relations:—

$$\sin b=\sin n \sin \phi-\cos n \cos \phi \cos m$$
$$\cos b \sin k=\cos n \sin m$$
$$\cos b \cos k=\sin n \cos \phi+\cos n \sin \phi \cos m$$

[1] Neglecting the difference of thickness of pivots, the point Q is defined by the Y's and is not moved over to the south by reversing the instrument.

and

$$\sin n = \sin b \sin \Phi + \cos b \cos \Phi \cos k$$
$$\cos n \sin m = \cos b \sin k$$
$$-\cos n \cos m = \sin b \cos \Phi - \cos b \sin \Phi \cos k.$$

Assume now that the telescope is directed to an object S, whose declination is δ and hour angle t, and that for *tube south* the distance between S and Q_1 is again $90° + c$, then, considering that the angle S P Q_1 is $= 180° - m - t$, the following relation is obtained from triangle P S Q_1:

$$-\sin c = \sin n \sin \delta - \cos n \cos \delta \cos (m+t) \quad . \quad . \quad . \quad . \quad (1) \text{ [Tube south]}$$

This formula is the same whether the instrument is pointed to the east or the west, the only change being in the value of t.

The effect of reversing the instrument to the position tube north is merely to change the sign of c, exactly as in the case of the instrument in the meridian. We have therefore

$$\sin c = \sin n \sin \delta - \cos n \cos \delta \cos (m+t) \quad . \quad . \quad . \quad . \quad (1a) \text{ [Tube north]}$$

If now we write (1) in the form

$$-\sin c = \sin n \sin \delta - \cos n \cos m \cos \delta \cos t + \cos n \sin m \cos \delta \sin t$$

and then express the functions of n and m in terms of b, k, and Φ by means of the formulæ at the top of the page, we have

$$\left.\begin{aligned} -\sin c = {} & \sin b \sin \Phi \sin \delta + \cos b \cos \Phi \cos k \sin \delta + \sin b \cos \Phi \cos \delta \cos t \\ & - \cos b \sin \Phi \cos k \cos \delta \cos t + \cos b \sin k \cos \delta \sin t \end{aligned}\right\} \quad . \quad . \quad (2)$$

Now take S $Z' = z'$ from the star perpendicular to the meridian, and put P $Z' = 90° - \Phi'$, then

$$\sin \delta = \cos z' \sin \Phi'$$
$$\cos \delta \cos t = \cos z' \cos \Phi'$$
$$\cos \delta \sin t = \sin z'$$

and substituting these values in (2)

$$-\sin c = \sin b \cos z' \cos (\Phi - \Phi') - \cos b \cos k \cos z' \sin (\Phi - \Phi') + \cos b \sin k \sin z';$$

or

$$\tan (\Phi - \Phi') = \frac{\sin c \sec z'}{\cos b \cos k \cos (\Phi - \Phi')} + \frac{\tan b}{\cos k} + \frac{\tan k \tan z'}{\cos (\Phi - \Phi')} \cdot \quad \left\{\begin{matrix}\text{Tube south, star} \\ \text{west or east}\end{matrix}\right\}$$

It is necessary to note that when the star is to the east, z', and consequently tan z', become negative along with t, as is evident from the formula

$$\cos \delta \sin t = \sin z'.$$

On reversing the axis the formula becomes

$$\tan (\Phi - \Phi') = -\frac{\sin c \sec z'}{\cos b \cos k \cos (\Phi - \Phi')} + \frac{\tan b}{\cos k} + \frac{\tan k \tan z'}{\cos (\Phi - \Phi')} \cdot \quad \left\{\begin{matrix}\text{Tube north, star} \\ \text{west or east}\end{matrix}\right\}$$

These formulæ are perfectly general.[1]

[1] See Brünnow (*Spherical Astronomy*, London, 1865) and C. F. W. Peters (*Ast. Nach.* No. 1911).

By reversing the instrument at each observation the term involving c disappears, and when b and k are sufficiently small we have simply

$$\phi - \phi' = b + k \tan z'.$$

From the stars that are observed both east and west a closely approximate value of k is readily derived by neglecting the change of level; for if t_1 and t are the true hour angles at the eastern and western observations of any star,

$$k = -\frac{t_1 + t}{2} \sin \phi.$$

OBSERVATIONS OF STARS IN

Date, 1874	Transit	Position of tube	Star	Set of wires	Wires I.	Wires II.	Wires III.	Wires IV.	Wires V.	Level S	Level N
					s.	s.	s.	s.	h. m. s.	p.	p.
Dec. 29	E	North	*a* Leporis	A	44·5	59·5	15·7	28·5	3 31 45·0	−22·2	+15·3
Chron. 43				B	9·5	...	41·0	57·1	3 34 11·5	−22·9	+14·9
	„	South	„	A	2·0	45·0	27·7	12·4	3 41 55·5	−12·8	+25·0
				B	24·5	...	51·5	35·0	3 39 19·3	−14·4	+23·1
	E	North	54 Eridani	C	48·2	13·5	39·1	5·2	4 2 34·0	−23·3	+14·2
										−23·6	+14·2
	„	South	„	C	34·0	52·0	10·8	30·0	4 12 47·5	−14·0	+23·9
										−15·1	+22·6
	W	North	54 Eridani	C	28·3	3·5	38·8	12·0	5 7 44·5	−23·9	+14·4
										−23·9	+14·4
	„	South	„	C	48·0	30·2	11·5	52·7	4 57 33·9	−12·7	+25·5
										−13·0	+25·1
	W	North	Lalande 10874*	A	49·5	31·3	13·2	56·0	7 14 37·0	−20·1	+17·9
				B	57·0	...	19·7	0·8†	7 11‡ 42·7	−21·3	+16·8
	„	South	„	A	...	6·5	28·0	47·5	7 2 9·2	−25·0	+13·0
				B	2·0	...	42·2	2·5	7 5 21·2	−25·5	+12·6
Dec. 30	E	North	*a* Leporis	B	18·25	...	48·8	5·4	3 35‡ 19·8	−22·2	+14·3
E.C.Chron.				C	2·4	10·6	18·1	25·8	3 36‡ 34·8	−22·2	+14·2
	„	South	„	B	34·1	...	0·8	44·5	3 40‡ 29·0	−19·5	+18·2
				C	45·1	36·2	28·5	...	...	−20·0	+16·9
	E	North	54 Eridani	C	55·1	28·2	48·0	14·4	4 3‡ 41·0	−22·0	+15·0
										−22·2	+14·8
	„	South	„	C	53·6	8·5	29·9	49·7	4 14‡ 6·5	−15·2	+21·9
										−19·8	+17·3
	W	North	54 Eridani	C	...	...	...	...	5 8 54·0	−21·7	+15·8
										−21·6	+15·8
	„	South	„	C	...	15·6	0·0	38·8	4 58 24·2	−21·0	+16·8
										−21·3	+16·0

* Lalande 10874 was observed by mistake.

† 50°·8 in original.

‡ Hour and minute supplied.

The whole of the observations were made by Mr. Gill by the eye and ear method, with a power of 153. The reductions have been performed by Dr. Copeland and Mr. H. J. Carpenter.

The tabular statement of the observations gives all the recorded data, and also the principal steps of the reductions. The contents of most of the columns are sufficiently explained by the headings. In all cases the stars were observed in reversed positions of the axis, and as far as possible at both eastern and western transits. The apparent places of the stars include the corrections for daily aberration.

THE PRIME VERTICAL AT BELMONT.

Transits reduced to middle wire					Mean of transits north and south	Level *in arc*	Apparent R.A. and declination	$k_0 \tan z$	ϕ'
I.	II.	III.	IV.	V.					
s.	s.	s.	s.	s.	h. m. s.	"		′ "	° ′ "
44·57	44·05	44·73	43·62	44·38					
44·13	...	44·48	44·70	44·15	3 36 43·74	+0·74	h. m. s. 5 27 14·19	−1 27·35	−20 1 31·48
43·04	43·17	42·98	42·89	43·18			° ′ ″ −17 54 43·28		
43·30	...	43·26	43·45	43·36					
13·53	14·16	14·13	13·80	15·16	4 7 12·32	−0·14	h. m. s. 4 34 59·42	−0 20·11	−20 2 37·17
10·25	10·40	10·85	11·10	9·77			° ′ ″ −19 54 43·78		
2·31	2·26	3·31	2·91	3·00	5 3 6·92	+0·73	h. m. s. 4 34 59·42	+0 20·98	−20 3 18·83
11·08	11·12	10·80	11·31	11·16			° ′ ″ −19 54 43·76		
38·69	38·84	39·14	38·38	38·08					
38·98	...	38·88	39·02	38·80	7 8 35·40	−3·90	h. m. s. 5 37 54·44	+1 10·37	−20 4 2·68
...	31·63	31·79	32·31	32·61			° ′ ″ −18 36 52·13		
32·52	...	32·13	31·91	31·43					
52·95	...	52·33	53·05	52·50					
52·68	53·18	52·79	52·45	53·18	3 37 52·74	−2·51	h. m. s. 5 27 14·19	−1 27·34	−20 1 29·21
52·80	...	52·47	52·86	52·99			° ′ ″ −17 54 43·51		
53·10	52·14	52·55	...	...					
20·81	29·97	23·54	23·51	22·44	4 8 25·14	−1·26	h. m. s. 4 34 59·42	−0 20·05	−20 2 34·63
25·91	23·87	26·90	28·05	26·47			° ′ ″ −19 54 44·00		
...	...	...	...	13·00	5 4 8·08	−2·62	h. m. s. 4 34 59·42	+0 20·90	−20 3 14·89
...	2·25	4·00	1·50	4·90			° ′ ″ −19 54 43·98		

OBSERVATIONS OF STARS IN THE

Date, 1874–75	Transit	Position of tube	Star	Set of wires	Wires I.	Wires II.	Wires III.	Wires IV.	Wires V.	Level S	Level N
					s.	s.	s.	s.	h. m. s.	p.	p.
Dec. 30 (*cont.*)	W	North	*a* Leporis	B	48·1	...	16·8	59·3	7 21 45·8	−21·2	+16·6
				C	3·5	56·4	48·0	39·0	7 20 31·8	−21·2	+16·6
	„	South	„	B	...	...	58·4	14·8	7 16 30·6	−21·1	+16·8
				C	14·3	22·7	30·1	38·8	7 17 47·2	−23·1	+14·5
Dec. 31 E.C. Chron.	E	North	*a* Leporis	A	50·8	6·0	...	...	3 32 50·8	...	...
				B	15·5	...	46·8	3·0	3 35 17·4	−17·3	+19·6
	„	South	„	A	12·0	...	...	23·0	3 43 5·0	−19·0	+18·1
				B	34·0	...	1·5	44·0	3 40 28·8	−21·9	+15·2
	E	North	*β* Canis maj.	A	23·0	38·0	53·5	7·1	4 22* 23·2	−21·0	+16·2
				B	47·1	...	18·5	34·2	4 24 48·5	−22·0	+15·2
	„	South	„	A	38·8	22·0	4·5	49·9	4 32 32·2	−14·3	+23·0
				B	1·2	...	28·5	...	...	−16·0	+21·4
	W	North	54 Eridani	C	39·0	13·8	49·2	23·0	5 8 54·0	−19·4	+18·3
										−19·6	+18·3
	„	South	„	C	49·0	31·8	12·8	52·1	4 58 32·2	−16·2	+21·2
										−17·0	+20·7
	W	North	*a* Canis maj.	A	48·7	36·5	24·5	13·3	9 7 0·0	−16·9	+21·2
				B	51·4	...	26·5	14·0	9 5 2·1	−17·6	+20·7
	„	South	„	A	2·5	16·2	29·1	40·0	8 58 54·2	−13·2	+25·0
				B	5·1	...	30·8	44·5	9 0 57·0	−15·2	+22·9
Jan. 1 E.C. Chron.	W	North	*β* Ceti	A	28·8	10·8	51·4	35·3	2 13 15·8	−20·1	+16·9
				B	33·0	...	55·0	...	2 10 17·5	−23·0	+14·2
	„	South	„	A	14·5	36·1	57·0	16·2	2 0 38·8	−16·5	+20·1
				B	34·2	...	15·5	36·5	2 3† 55·5	−17·3	+19·7
	E	North	*a* Leporis	B	14·5	...	46·2	1·3	3 35 16·5	...	...
										−19·3	+18·5
	„	South	„	B	31·0	...	59·1	41·5	3 40‡ 26·7	−14·3	+23·5
										−14·8	+23·1
	E	North	*a* Canis maj.	A	2·5	15·3	28·1	39·2	4 14§ 52·0	−18·8	+19·1
				B	0·3	...	25·2	...	4 16 49·5	−18·8	+19·0
	„	South	„	A	49·2	36·1	22·6	11·0	4 22 57·5	−13·0	+24·9
				B	46·1	...	20·5	7·0	4 20 55·5	−14·0	+23·9
	W	North	54 Eridani	C	36·0	10·5	47·0	19·5	5 8 52·0	−18·6	+19·8
										−21·0	+17·2
	„	South	„	C	53·5	35·0	16·8	59·1	4 58 39·0	−12·8	+25·4
										−12·2	+25·8

* 27^m in original. † 8^m in original. ‡ 45^m in original. § 9^m in original.

NOTE.—The dial of the electric-contact chronometer is numbered from 0 to 23 hours, but there are no figures to the minutes, hence the frequent errors in the latter.

PRIME VERTICAL AT BELMONT (*continued*).

Transits reduced to middle wire					Mean of transits north and south	Level *in arc*	Apparent R.A. and declination	$k_0 \tan z$	ϕ'
I.	II.	III.	IV.	V.					
s.	s.	s.	s.	s.	h. m. s.	"		′ "	° ′ "
13·50	...	13·36	11·72	13·17					
13·28	13·88	13·36	12·38	13·46	7 19 9·83	−2·72	h. m. s. 5 27 14·19	+1 28·36	−20 4 21·71
...	...	6·81	6·51	6·68			−17° 54′ 43″47		
6·35	6·81	6·10	6·55	6·47					
50·91	50·59	...	...	50·20					
50·15	...	50·29	50·61	50·06	3 37 51·60	−0·38	h. m. s. 5 27 14·19	−1 27·33	−20 1 29·21
52·81	...	...	53·29	52·49			−17° 54′ 43″75		
52·68	...	53·16	52·35	52·77					
21·76	21·30	21·33	21·08	21·49					
20·93	...	21·29	21·16	20·57	4 27 21·23	+0·31	h. m. s. 6 17 12·86	−1 27·78	−20 1 29·05
21·34	21·60	21·14	21·68	21·11			−17° 53′ 37″13		
20·87	...	20·98	...	...					
14·08	13·54	14·62	14·81	13·21	5 4 13·38	+0·78	h. m. s. 4 34 59·41	+0 20·98	−20 3 19·06
13·64	14·04	13·32	11·66	10·83			−19° 54′ 44″20		
0·17	0·51	1·06	1·08	0·48					
0·08	...	0·17	0·41	0·46	9 3 0·10	+3·32	h. m. s. 6 39 39·37	+2 0·25	−20 5 2·32
59·79	60·20	59·83	58·92	59·74			−16° 32′ 40″50		
59·48	...	59·35	59·95	60·17					
9·44	10·14	9·44	10·14	9·67					
9·70	...	9·64	...	9·79	2 7 10·07	−0·74	h. m. s. 0 37 18·62	+1 8·71	−20 4 50·30
11·31	10·99	10·10	9·88	10·55			−18° 40′ 32″28		
10·48	...	10·28	10·30	9·71					
49·13	...	49·68	48·90	49·15	3 37 49·76	+1·96	h. m. s. 5 27 14·18	−1 27·34	−20 1 30·77
49·75	...	50·81	49·90	50·71			−17° 54′ 43″99		
51·08	51·34	51·60	51·48	51·57					
51·65	...	51·55	...	51·16	4 18 51·66	+2·75	h. m. s. 6 39 39·38	−1 59·00	−20 0 58·27
51·85	51·97	51·82	52·04	51·92			−16° 32′ 40″87		
51·70	...	51·93	51·53	52·30					
10·63	9·78	12·09	10·89	10·95	5 4 13·59	+2·91	h. m. s. 4 34 59·41	+0 21·00	−20 3 20·22
16·40	15·88	15·98	17·10	16·18			−19° 54′ 44″42		

OBSERVATIONS OF STARS IN THE

Date, 1875	Transit	Position of tube	Star	Set of wires	Wires					Level	
					I.	II.	III.	IV.	V.	S	N
					s.	s.	s.	s.	h. m. s.	p.	p.
Jan. 1 (*cont.*)	W	North	α Leporis	B	44·8	...	13·5	...	7 21* 43·2	−18·3 −19·2	+20·1 +19·2
	,,	South	,,	B	25·3	...	58·0	15·0	7 16 30·8	−20·5 −21·5	+17·7 +16·8
	E	North	μ Hydræ	A	39·1	...	2·5	13·1	7 48 26·0	−19·5	+19·1
				B	30·9	...	55·2	...	7 50 18 8	−19·6	+19·0
	,,	South	,,	A	...	47·1	34·8	23·9	7 56 11·0	−14·0	+24·8
				B	2·4	...	...	25·0	...	...	...
	W	North	β Canis maj.	A	35·5	20·5	4·8	51·5	8 14 35·5	−19·8	+19·1
				B	11·0	...	40·1	24·0	8 12 9·2	−21·9	+17·0
	,,	South	,,	A	17·3	35·0	52·0	7·1	8 4† 24·9	−18·0	+20·5
				B	56·0	...	28·0	44·6	8 6 59·8	−17·9	+21·9
	W	North	α Canis maj.	A	46·5	34·8	22·0	10·8	9 6 58·1	−18·1	+21·1
				B	49·8	...	24·5	...	9 5 0·5	−19·7	+19·8
	,,	South	,,	A	1·2	14·0	28·1	39·2	8 58 53·0	−14·5	+25·0
				B	3·9	...	28·5	43·1	9 0 55·0	−15·3	+24·0

* 16^m in original. † 9^m in original.

MEAN PLACES OF THE STARS FOR 1875·0.

The places of β Ceti and α Leporis were taken from Boss' 'Declinations of Fixed Stars.' The 'Berliner Jahrbuch' was chosen as the authority for Sirius, as the star's place is corrected in accordance with the investigations of Auwers. For the remaining stars the places of the chief catalogues were combined by bringing them up to 1875·0 by Struve's constants, and by the application of Newcomb's and Boss' systematic corrections to the right ascensions and declinations respectively. Where any proper motion was perceptible its most probable value was deduced by the method of least squares. The following are the reduced catalogue places and final results for 1875·0, as well as the residuals whenever a proper motion has been computed.

1. *β Ceti.*

Authority	α (1875·0)	δ (1875·0)
	h. m. s.	° ′ ″
Boss	0 37 18·8	−18 40 23·23
Annual var.	+3·012	+19·81

PRIME VERTICAL AT BELMONT (*continued*).

Transits reduced to middle wire					Mean of transits north and south	Level *in arc*	Apparent R.A. and declination	$k_0 \tan z$	ϕ'
I.	II.	III.	IV.	V.					
s.	s.	s.	s.	s.	h. m. s.	"	h. m. s.	′ "	° ′ "
10·18	...	10·04	...	10·56	7 19 8·44	−0·70	5 27 14·18	+1 28·39	−20 4 25·28
6·62	...	6·36	6·66	6·83			−17° 54′ 43″·95		
15·90	...	15·19	15·02	15·72					
15·15	...	15·47	...	15·39	7 52 15·58	+2·55	h. m. s. 10 20 3·10	−2 6·86	−20 0 51·78
...	15·48	15·84	16·24	16·12			−16° 11′ 47″·68		
15·53	...	...	15·36	...					
36·82	37·27	37·04	37·58	37·28					
37·20	...	37·34	37·07	37·15	8 9 35·94	+0·11	h. m. s. 6 17 12·86	+1 28·83	−20 4 25·72
33·21	33·90	33·95	33·96	34·70			−17° 53′ 37″·35		
36·36	...	35·54	35·52	35·17					
57·92	58·78	58·52	58·54	58·55					
58·46	...	58·16	...	58·85	9 2 58·35	+2·75	h. m. s. 6 39 39·38	+2 0·24	−20 5 1·09
58·51	58·02	58·84	58·12	58·54			−16° 32′ 40″·73		
58·28	...	57·07	58·55	58·18					

2. 54 *Eridani*.

Authority	Epoch	α (1875·0) h. m. s.	Observations	Epoch	δ (1875·0)	Observations	C−O
Piazzi	1800·0	4 34 58·34	18	1800·0	−19° 54′ 37″·89	14	−0″·15
Armagh	1829·0	58·34	1	1846·0	41·80	2	−1·07
Johnson	1831·5	58·46	11	1831·5	40·96	11	−0·38
Taylor	1832·5	58·46	18	1832·0	43·09	8	+1·69
Greenwich 6-year	1850·5	58·41	7	1850·6	43·45	6	+0·10
Radcliffe 2	1857·0	58·38	2	1856·6	43·56	4	−0·42
Washington	1862·6	58·42	2	1866·0	44·19	2	−0·78
	1875·0	4 34 58·40			−19 54 45·91		
Annual prec.		+2·621		Annual var.	+7·17		
				Proper mot.	−0·105 for 1850		

3. α *Leporis*.

Authority	α (1875·0) h. m. s.	δ (1875·0)
Boss	5 27 13·1	−17° 54′ 48″·06
Annual var.	+2·645	+2·86

4. *Lalande* 10874.

Authority	α (1875·0) h. m. s.	Weight	δ (1875·0)	Weight
Lalande (Von Asten)	5 37 53·27	1	−18° 36′ 56″·86	1
Bonn Observations VI.	53·35	3	57·51	3
1875·0	5 37 53·33		−18 36 57·35	
Annual prec.	+2·624		+1·93	

Lalande's observation was first reduced to Wolfers by Argelander's correction (+0ˢ·01 and −0″·39), and then to Boss' by assuming the same correction as for Bonn Obs. VI. The Bonn result has been corrected by −0″·48, in accordance with Bonn Obs. VI., p. xiv., and then reduced to Boss.

5. *β Canis majoris.*

Authority	Epoch	α (1875·0) h. m. s.	Weight	Epoch	δ (1875·0)	Weight	C−O
Bradley	1755·0	6 17 11·77	1	1755·0	−17° 53′ 43″·17	1	−2·07
Piazzi	1800·0	11·65	2	1800·0	48·05	1	+3·51
Johnson	1831·5	11·65	2	1831·5	44·17	2	+0·12
Armagh	1836·6	11·70	2	1853·0	(38·13)	(0)	(−5·58)
Greenwich 12-year	1845·0	11·81	1	1838·0	43·57	2	−0·38
„ 6-year	1850·0	11·81	1	1850·0	43·72	1	−0·04
„ 7-year	1860·0	11·78	1	1860·0	44·46	1	+0·86
Radcliffe 2	1860·0	11·81	2	1860·0	43·89	2	+0·29
Greenwich 2nd 7-year	1864·0	11·71	3	1864·0	42·98	1	−0·56
„ 9-year	1872·0	11·72	3	1872·0	42·94	2	−0·48
Mean of last five	1875·0	6 17 11·75			−17 53 43·37		
Annual prec.		+2·64		Annual var.	−1·49		

Annual prop. mot. in δ = +0·0156 for 1850·0

6. *α Canis majoris.*

	α (1875·0) h. m. s.	Ann. var. s.	δ (1875·0)	Ann. var.
'Berliner Jahrbuch,' 1875·0	6 39 38·282	+2·6514	−16° 32′ 47″·48	−4″·728

7. *μ Hydræ.*

Authority	Epoch	α (1875·0) h. m. s.	Weight	C−O s.	Epoch	δ (1875·0)	Weight	C−O
Bradley	1755·0	10 20 3·98	2	−0·24	1755·0	−16° 11′ 43″·44	2	−0″·54
Piazzi	1800·0	3·23	3	+0·14	1800·0	48·99	3	+0·39
Åbo	1830·0	3·08	3	+0·04	1830·0	51·48	3	−0·21
Armagh	1833·2	3·08	2	+0·02	1837·2	52·88	2	+0·45
Greenwich 6-year	1850·0	2·98	2	−0·02	1850·0	53·77	3	+0·03
„ 7-year	1860·0	2·89	1	−0·02	1860·0	55·29	1	+0·52
Washington	1859·3	2·89	1	−0·01	1871·0	55·74	3	−0·16
Radcliffe 2	1860·0	2·82	2	+0·05	1860·0	54·90	2	+0·13
Greenwich 2nd 7-year	1864·0	2·85	5	−0·01	1864·0	55·37	2	+0·19
„ 9-year	1872·0	2·80	5	−0·03	1872·0	55·54	2	−0·46
	1875·0	10 20 2·75				−16 11 56·31		
Annual var.		+2·90				−18·04		
Annual prop. mot. for 1850·0		−0·0083				−0·1027		

The reductions were greatly simplified by adopting the chronometer corrections found by observations with the instrument turned into the meridional Y's, the details of which will be published in another volume. The results necessary for our present purpose are :—

Chronometer 43.

	Chronometer time h. m.	Correction s.	Daily var. s.
1874, Dec. 29	3 3·3	+24·81	+2·89

Electric-contact Chronometer.

	Chronometer time	Correction	Daily var.
	h. m.	s.	s.
1874, Dec. 30	1 58	[−43·205*]	+1·212
„ „ 31	1 58	[−41·96 *]	+1·278
1875, Jan. 1	1 58	−40·65	+1·342

[*] These corrections have been interpolated, taking the rates of (43) and Walker 174 into account.

With $-20^\circ\ 3'$ as an approximate value of the latitude, the azimuth k was provisionally computed from the stars observed both east and west, as follows :—

		$\frac{t_1+t}{2}$	k
		s.	
Dec. 29	54 Eridani	+35·48	+182″·46
„ 30	α Leporis	+34·05 (wt. 3)	+174·95
„ „	54 Eridani	+33·94 (wt. 1)	
„ 31			[+177·07]
Jan. 1	α Leporis	+34·41	+179·19
„ „	α Canis maj.	+35·28	

On December 31, as no star was observed both east and west, the value of k was interpolated. The change of azimuth between December 29 and 30 is probably due to the foot-screws of the instrument having been altered, to lessen the error in level.

The reductions to the middle wire were made by the formula

$$\sin\ \tfrac{1}{2}\ (t_m - t) = \frac{f'}{2\ \cos\ \delta\ \sin\ \phi\ \sin\ \tfrac{1}{2}\ (t_m + t)},$$

in which

$$f' = \frac{f}{1 - b\ \cot\ \phi + k\ \cot\ \tfrac{1}{2}\ (t_m + t)\ \operatorname{cosec}\ \phi},$$

where f is the equatorial wire interval found by observations in the meridian ; b the inclination of the axis ; t_m and t the hour angles of the middle and side wires.

By taking the mean of transits in reversed positions of the axis the effect of the small error in collimation was eliminated, thus permitting the application of Bessel's method of combining the transits in a very simple form.

Let ϕ_0 and k_0 be the assumed latitude and azimuth, and $\Delta\phi$ and Δk the required corrections of these quantities, then each complete observation east or west gives an equation of the form

$$0 = n - \Delta\phi + \tan\ z'\ \Delta k,$$

in which

$$n = \phi' + + k_0\ \tan\ z' - \phi_0.$$

From the totality of the equations on each night, $\Delta\phi$ and Δk were derived by the method of least squares. The following are the equations obtained by assuming $\phi_0 = -20^\circ\ 2'\ 57''{\cdot}00$ and $k_0 = +178''{\cdot}42$, with the resulting normal equations and values of $\Delta\phi$ and Δk. To the right of the equations of condition are shown the final residuals :—

EQUATIONS OF CONDITION. NORMAL EQUATIONS.

December 29.

					Residuals				
0	=	−1·09	−Δφ	−0·490 Δk	−0″·07	0	=	+0″·8400	+4·000 Δφ	+0·0910 Δk
0	=	−0·42	−Δφ	−0·113 Δk	+0·03	0	=	+0·8797	+0·091 Δφ	+0·4220 Δk
0	=	−0·12	−Δφ	+0·118 Δk	+0·20					
0	=	−0·79	−Δφ	+0·394 Δk	−0·14			Δφ = −0″·16		Δk = −2″·05

December 30.

					Residuals				
0	=	−2·06	−Δφ	−0·489 Δk	+0″·80	0	=	−0″·3200	+4·000 Δφ	−0·0110 Δk
0	=	+1·06	−Δφ	−0·112 Δk	−1·30	0	=	+1·3946	−0·011 Δφ	+0·5103 Δk
0	=	+0·39	−Δφ	+0·117 Δk	0·00					
0	=	+0·93	−Δφ	+0·495 Δk	+0·49			Δφ = +0″·07		Δk = +2″·73

December 31.

					Residuals				
0	=	+0·08	−Δφ	−0·489 Δk	+0″·28	0	=	−1″·4900	+4·000 Δφ	+0·1890 Δα
0	=	+0·48	−Δφ	−0·492 Δk	−0·11	0	=	−1·4902	+0·189 Δφ	+0·9494 Δα
0	=	−0·30	−Δφ	+0·118 Δk	−0·35					
0	=	−1·75	−Δφ	+0·674 Δk	+0·18			Δφ = −0″·45		Δk = +1″·66

January 1.

					Residuals				
0	=	−0·33	−Δφ	+0·385 Δk	+0″·14	0	=	−3″·1300	+8·000 Δφ	−0·3020 Δk
0	=	+0·85	−Δφ	−0·490 Δk	+0·41	0	=	−3·6871	−0·302 Δφ	+2·2999 Δk
0	=	+2·48	−Δφ	−0·667 Δk	−0·92					
0	=	+0·69	−Δφ	+0·118 Δk	−0·44					
0	=	−0·59	−Δφ	+0·495 Δk	+0·22					
0	=	+0·91	−Δφ	−0·711 Δk	+0·72			Δφ = +0″·45		Δk = +1″·66
0	=	+0·22	−Δφ	+0·498 Δk	−0·60					
0	=	−1·10	−Δφ	+0·674 Δk	+0·43					

The results for the individual days are therefore :—

				Weight
Dec. 29	−20°	2′	57″·16	(1)
„ 30			56·93	(1)
„ 31			57·45	(1)
Jan. 1			56·55	(2)

Whence the mean

$$-20^\circ\ 2'\ 56''\cdot93 \pm 0''\cdot10$$

In the last chapter we found the latitude from circum-meridian altitudes, when referred to the site of the transit instrument, to be 20° 2′ 58″·41 ± 0″·37.

Combining these results, we have :—

Latitude of the Transit Pier at Belmont . . . −20° 2′ 57″·03 ± 0″·10

CHAPTER XXII.

DEDUCTION OF THE LONGITUDE OF BELMONT FROM TRANSITS OF THE MOON AND OCCULTATIONS OF STARS.

a. Transits of the Moon.

The details of these observations with the reversing transit instrument and their reductions will be given in the fourth volume of the Dun Echt publications, but, with a view to collecting in one place all the materials bearing on the longitude of Belmont, the derived sidereal times of the transit of the moon's centre will here be used for the computation of the longitude.

Corrections to Hansen's tables of the moon near the time of the Transit of Venus in 1874 have already been deduced by Professor Newcomb on the basis of observations made at Greenwich and Washington, having at the same time regard to the methods followed in the original construction of the tables.[1] Subsequently Colonel Tupman derived somewhat different corrections by a purely graphical method, using an extended range of observations.[2]

The recent electrical connections of the Melbourne and Cape observatories with Greenwich and the communication of observations of the moon made at Leyden having rendered still further materials available, it seemed possible to represent yet more closely the moon's motion during the short period embracing the observations at Belmont and thus obtain a result for the longitude which shall be liable only to a very small future correction, in so far as the moon's place is concerned.

Before proceeding further it is necessary to point out a small but systematic discrepancy between two classes of corrections to the lunar ephemerides as derived at different observatories. At Washington, Paris, and some other places, it is the custom to reduce an observation of the moon's limb to the centre, and then compare this reduced place with the ephemerides on pp. V.–XII. of each month of the Nautical Almanac. This method is strictly accurate. At Greenwich and elsewhere the observed places are compared directly with the '*Apparent* Right Ascension at Transit at Greenwich' given in the Nautical Almanac with the moon-culminating stars. The corrections thus obtained are too large by the amount of the moon's motion during the interval of sidereal time equal to the correction in right ascension. In other words, the tabular right ascension of the moon's limb does not represent the sidereal time of transit over the meridian; and since the correction prior to 1883 is always negative, the epoch of the moon-culminating ephemerides is always too late, and the moon's '*apparent* right ascension' larger than the tabular amount at the time of actual transit. This excess in 1874 was occasionally as

[1] Papers published by the Commission on the Transit of Venus, Part III. Washington, 1876.
[2] *Monthly Notices*, xxxvii. p. 249.

much as $0^s.04$, while in 1881 it ranged from $0^s.02$ to $0^s.04$ and even to $0^s.06$ in an extreme instance. It is further evident that in determining longitudes by the moon, the neglect of this quantity at one of the stations introduces an error into the *longitude* exactly equal to the correction to Hansen's tables. Slight errors in the corrections to the moon's declination necessarily arise from the same source, but they are less in magnitude besides being variable in sign. The introduction of Professor Newcomb's corrections into the Nautical Almanac for 1883 and subsequent years, has practically rendered these differences inappreciable.

The following summary shows the sources whence the observations of the moon's right ascension have been derived, and also such subsidiary corrections as were requisite to bring the right ascensions of the determining stars into conformity with those of the clock-stars adopted at Greenwich. The observations were in each case compared with the moon's hourly ephemeris.

MELBOURNE. *Ast. Nach.* No. 2044. Longitude $9^h\ 39^m\ 53^s.83$ E., *M.N.* XLIV., p. 183. The right ascensions were assumed as homogeneous with those at Greenwich.

KÖNIGSBERG. *Ast. Nach.* No. 2050. Longitude $1^h\ 21^m\ 59^s.32$ E., see *M.N.* XXXVII., p. 250, also with respect to the corrections. The observations of December 2 and 3 were reduced to the Greenwich standard by means of the comparison stars, that of November 14 was not used, as the solitary star's place rests upon a single wire only. The applied corrections are: December 2, $-0^s.07$; December 3, $-0^s.16$.

CAPE OF GOOD HOPE. From the 1874 volume of observations, p. 191, taking the longitude at $1^h\ 13^m\ 54^s.742$ E., see *M.N.* XLIII., p. 418, and considering the right ascensions as resting on the same foundation as those at Greenwich.

STRASSBURG. The comparisons of the transit of the moon's limb with the ephemeris of the Nautical Almanac have been derived from *Ast. Nach.* No. 2050, with further corrections to the star places of $-0^s.05$, $-0^s.05$, $-0^s.03$, $-0^s.02$ and $0^s.00$, on the assumption that Auwers's right ascensions were used.

LEYDEN. The observed places of the moon and the difference of meridians, $17^m\ 56^s.21$ E., were kindly communicated by Professor van de Sande Bakhuyzen, but, as they were based on the fundamental list for the zones of the *Astronomische Gesellschaft*, small corrections have been applied for the difference between that list and the Greenwich clock-stars for 1875·0. The corrections for the various days are: in November, $-0^s.05$, $-0^s.05$, $-0^s.04$, $-0^s.02$, $-0^s.01$, and in December, $-0^s.02$, $-0^s.02$, $-0^s.02$, $-0^s.04$ and $-0^s.03$.

PARIS, GREENWICH, OXFORD, and WASHINGTON corrections were taken or deduced from the *Comptes rendus*, t. 80, p. 1265 (with slight changes to accord with a longitude of $9^m\ 21^s.0$ E.), and the respective volumes of observations. Whenever two instruments were used at Paris the simple mean of the results has been adopted, while an evidently erroneous observation on December 21 at Oxford has been omitted.

Excluding the last-named observation and that at Königsberg on November 14, there remained eighty-four observations between November 14 and December 27, 1874. These were

referred to Greenwich mean time, and compared with the hourly ephemeris for the moon in the Nautical Almanac. The corrections were then laid down on cross-lined paper and compared *inter se* and with Professor Newcomb's corrections. It then became evident that the curve formed by the latter closely resembled that which best represented the observations, but was rather less in amplitude, besides being about one day behind in the November lunation and a day and a half in that of December. This is clearly seen in the following table, in which the residuals show a probable deviation of a single observation from the curve to be $\pm 0^{s}\cdot 07$. The initials are those of the observatories. It will be noticed that there is still a want of observations on November 28 and 29; here Professor Newcomb's figures were of great use in directing the course of the curve.

CORRECTIONS TO THE HOURLY EPHEMERIS OF THE NAUTICAL ALMANAC DERIVED FROM HANSEN'S 'TABLES DE LA LUNE,' AFFORDED BY OBSERVATIONS COMPARED WITH A CURVE SHOWING THE MEAN CORRECTION.

Date and Observatory	Correction by		C–O	New-comb	Date and Observatory	Correction by		C–O	New-comb	Date and Observatory	Correction by		C–O	New-comb
	Obs.	Curve				Obs.	Curve				Obs.	Curve		
G. M. T. 1874	s.	s.	s.	s.	G. M. T. 1874	s.		s.	s.	G. M. T. 1874	s.	s.	s.	s.
Nov. 13·75 M.	−·49	−·35	+·14	−·52	Nov. 23·49 P.	·56	−·73	−·17	−·80	Dec. 15·22 P.	−·25	−·45	−·20	−·52
14·17 P.	−·25	−·35	−·10	−·52	23·50 O.	−·85	−·73	+·12	−·80	15·45 W.	−·38	−·45	−·07	−·52
14·40 W.	−·21	−·35	−·14	−·52	24·12 M.	−·82	−·79	+·03	−·86	15·84 M.	−·46	−·46	·00	−·53
15·19 S.	−·54	−·35	+·19	−·52	24·52 S.	−·67	−·83	−·16	−·89	16·26 O.	−·66	−·47	+·19	−·55
16·23 L.	−·21	−·35	−·14	−·51	24·53 L.	−·99	−·84	+·15	−·89	16·88 M.	−·47	−·48	−·01	−·57
17·23 C.	−·36	−·35	+·01	−·51	24·54 P.	−·77	−·84	−·07	−·89	17·24 C.	−·45	−·49	−·04	−·58
17·27 L.	−·31	−·35	−·04	−·51	25·17 M.	−·81	−·90	−·09	−·93	17·29 G.	−·50	−·49	+·01	−·58
17·28 P.	−·27	−·35	−·08	−·51	25·58 L.	−1·13	−·93	+·20	−·94	17·91 M.	−·48	−·50	−·02	−·61
17·28 G.	−·41	−·35	+·06	−·51	25·58 P.	−·73	−·93	−·20	−·94	18·55 W.	−·55	−·52	+·03	−·64
18·26 C.	−·40	−·35	+·05	−·51	26·61 S.	−1·02	−·96	+·06	−·93	18·95 M.	−·59	−·53	+·06	−·66
18·32 O.	−·36	−·35	+·01	−·51	26·63 G.	−·81	−·96	−·15	−·93	19·35 L.	−·39	−·54	−·15	−·69
18·93 M.	−·34	−·36	−·02	−·52	27·66 L.	−1·05	−·93	+·12	−·89	19·36 G.	−·50	−·54	−·09	−·69
19·30 C.	−·48	−·37	+·11	−·53	30·76 L.	−·88	−·73	+·15	−·67	19·37 O.	−·69	−·54	+·15	−·69
19·34 P.	−·18	−·37	−·19	−·53	Dec. 1·80 G.	−·52	−·66	−·14	−·61	19·97 M.	−·61	−·57	+·04	−·73
19·35 G.	−·47	−·37	+·10	−·53	2·77 K.	−·53	−·60	−·07	−·56	20·39 L.	−·61	−·59	+·02	−·76
19·35 O.	−·41	−·37	+·04	−·53	2·81 L.	−·71	−·60	+·11	−·56	21·03 M.	−·64	−·64	·00	−·80
20·33 C.	−·41	−·43	−·02	−·56	2·82 P.	−·49	−·60	−·11	−·56	21·39 C.	−·64	−·68	−·04	−·82
20·38 G.	−·49	−·44	+·05	−·56	2·82 G.	−·69	−·60	+·09	−·56	21·45 G.	−·56	−·68	−·12	−·82
21·37 C.	−·63	−·52	+·11	−·63	3·80 K.	−·46	−·54	−·08	−·51	21·67 W.	−·50	−·70	−·20	−·83
21·40 S.	−·67	−·53	+·14	−·63	3·85 P.	−·56	−·54	+·02	−·51	22·44 C.	−·84	−·78	+·06	−·85
21·41 L.	−·60	−·53	+·07	−·63	4·47 M.	−·49	−·51	−·02	−·48	22·71 W.	−·91	−·81	+·10	−·86
21·41 P.	−·50	−·53	−·03	−·63	5·10 W.	−·53	−·50	+·03	−·47	23·12 M.	−·85	−·85	·00	−·86
21·64 W.	−·56	−·55	+·01	−·64	5·50 M.	−·56	−·49	+·07	−·46	23·76 W.	−·87	−·89	−·02	−·85
22·41 C.	−·53	−·62	−·09	−·71	12·76 M.	−·46	−·42	+·04	−·50	24·16 M.	−1·04	−·90	+·14	−·84
22·44 S.	−·52	−·62	−·10	−·71	13·78 M.	−·38	−·43	−·05	−·50	25·62 G.	−·75	−·84	−·09	−·76
22·46 G.	−·72	−·62	+·10	−·71	14·20 O.	−·54	−·44	+·10	−·51	25·84 W.	−·77	−·82	−·05	−·75
23·08 M.	−·65	−·68	−·03	−·76	14·42 W.	−·39	−·42	−·03	−·51	26·24 M.	−·84	−·79	+·05	−·72
23·45 C.	−·69	−·72	−·03	−·80	14·81 M.	−·47	−·44	+·03	−·52	27·27 M.	−·69	−·70	−·01	−·67

Reduction of the Right Ascensions of the Belmont Clock Stars to those of the Greenwich New Seven-Year Catalogue of 2760 Stars for 1864·0.

The right ascensions of the time stars used at Belmont not being in strict accordance with those of the Greenwich clock list, it became necessary to apply corrections to the observed Belmont places of the moon to make them comparable with observations made upon, or referred to, the Greenwich system of right ascensions. Whenever the Greenwich catalogue for 1864 afforded a sufficiently reliable place, it was adopted as final; in other cases the best accessible results were taken after the application of systematic corrections derived from Professor Newcomb's paper appended to the Washington observations for 1870. In forming the mean correction for each day the same weights were used for each star as in the computation of the clock error. A note shows whenever the place was derived from any other source than the 1864 catalogue :—

				s.
1874, Nov. 17.	74 Aquar.,* α Peg., ψ^1 Aquar.,† κ Pisc. :	−·101, −·044, −·011, −·025 ;	mean =	−·045
„ 19.	α Cass., B.A.C. 221,‡ η Pisc., α Ariet. :	−·078, −·022, +·017, −·034 ;	„	−·029
„ 22.	τ^2 Ariet., 33 Tauri § :	−·008 −·048 ;	„	−·028
„ 24.	B.A.C. 1746,‖ Lal. 11012,¶ ν Orion. :	+·094, +·004, −·043 ;	„	+·018
„ 25.	ν Orion., μ Gem., γ Gem., 53 Gem.,** ι Gem.†† :	−·043, −·028, −·055, −·069, −·020 ;	„	−·045
„ 26.	δ Gem., ω^1 Canc.,‡‡ ψ^2 Canc.§§ :	+·008, +·002, +·060 ;	„	+·023
„ 29.	ϵ Hyd., ϵ Leon. :	−·031, +·009 ;	„	−·011
„ 30.	α Leon., γ^1 Leon., ρ Leon., :	−·024, +·008, +·071 ;	„	+·018
Dec. 17.	B.A.C. 274,‖‖ ζ^1 Pisc.,¶¶ γ^2 Ceti :	−·038, −·044, −·044 ;	„	−·042
„ 18.	η Pisc., B.A.C. 609,*** 19 Ariet. :	††† +·017, +·001, +·003 ;	„	+·008
„ 19.	ξ^2 Ceti, γ^2 Ceti, α Pers.,‡‡‡ η Tauri :	+·006, −·044, −·094, +·012 ;	„	−·028
„ 22.	α Ceti, α Pers.,‡‡‡ η Tauri, γ^1 Erid. :	+·004, −·094, +·012, −·023 ;	„	−·025

The following table shows the right ascension of the moon's centre as afforded by the Belmont observations and the semidiameter, &c., of the Nautical Almanac, taking into account the corrections to the time determinations just deduced. $\frac{\Delta L}{\Delta \alpha}$ is the change in the longitude equivalent to one second of the moon's motion in right ascension. The corresponding Greenwich time and the longitude were found by interpolation from the moon's hourly places, checked by the data given with the moon-culminating stars, the correction for epoch, as explained at the foot of p. 473, being duly applied. To facilitate comparison with other observations the seconds of the longitude resulting from the use of Professor Newcomb's corrections have been added. Three places of decimals have been retained in the right ascensions to avoid error in the summation of numerous quantities :—

* 4 Washington observations, 1877 ; Stone 16 obs. ; 9-year cat. 4 obs.
‡ 8 Greenwich observations, beginning with 1864 cat.
‖ 5 Recent Greenwich observations.
** 7 Greenwich observations, beginning with 1860 cat. and 1 Dunsink observation.
†† 8 „ „ „ „ „ and 4 Dunsink observations.
‡‡ 5 „ „ „ 1864 „ and 2 „ „
§§ 25 „ „ „ „ „
¶¶ 48 „ „ „ „ „

† 20 Greenwich observations, beginning with 1864 cat.
§ 9 „ „ „ 1860 „
¶ 4 Dunsink observations, founded on the 1864 cat.
†† 18 Greenwich observations, beginning with 1860 cat.
‖‖ 7 „ „ „ 1864 cat.
*** 6 „ „ „ 1869
††† 6 „ „ „ 1864 cat.

Greenwich M. T. 1874	Observed R. A. of the Moon's centre at Belmont	Limb observed	Correction to N. A.	$\frac{\Delta L}{\Delta \alpha}$	Belmont East of Greenwich	Longitude by Newcomb's corrections
d.	h. m. s.		s.		h. m. s.	s.
Nov. 17·11	22 21 45·241	I.	−·350	27·1	3 50 39·9	35·7
19·18	0 6 55·330	I.	−·361	27·2	42·5	38·0
22·29	2 56 19·779	I.	−·610	23·1	42·0	40·0
24·38	5 8 5·129	II.	−·820	20·9	42·5	41·4
25·42	6 16 51·485	II.	−·918	21·2	44·5	44·2
26·47	7 23 34·257	II.	−·963	22·4	43·3	43·9
29·57	10 13 46·233	II.	−·801	29·5	45·3	46·7
30·61	11 1 11·491	II.	−·735	31·6	45·4	47·0
Dec. 17·13	0 38 39·418	I.	−·482	27·8	40·3	37·6
18·16	1 31 28·315	I.	−·504	26·5	40·6	37·5
19·20	2 27 25·774	I.	−·530	24·7	42·9	39·3
22·32	5 40 27·186	I.	−·770	20·9	39·0	37·2

Or

	h.	m.	s.	
Longitude of Belmont from the Moon's 1st limb	3	50	41·0	E.
" " " " 2nd "	3	50	44·2	E.
Longitude from Moon culminations	3	50	42·6	East ±0ˢ·27

The difference between the results for the two limbs is very strongly marked, the quantities scarcely overlapping. By combining all the observations without regard to the discordance of the two limbs, there results a longitude of $3^h\ 50^m\ 42^s{\cdot}35 \pm 0^s{\cdot}41$.

With Professor Newcomb's corrections the separate results are naturally less accordant than when the corrections are taken directly from the observations; they give the seconds of the longitude $37^s{\cdot}9$ for limb I., and $44^s{\cdot}6$ for limb II., with a mean of $41^s{\cdot}3$; the difference between the limbs being even more strongly marked than before.

b. Occultations of Stars.

Occultations of stars by the Moon were observed on nearly all favourable occasions during the month of November; but in the following month the pressure of other work, combined with failing health, prevented any material addition to our store of observations of this class. In planning the distribution of the three available telescopes, they were intentionally placed sufficiently far apart to put each observer fairly out of earshot of his neighbour, or at least so that each one might be under no apprehension of disturbing the other members of the party by his movements. Lord Lindsay observed invariably with a 4-inch equatorial of 59·5 inches focus by Cooke and Sons, at a spot $0^s{\cdot}018$ west and $1''{\cdot}79$ north of the centre of the transit instrument, which was taken as the fundamental point of the whole station. Mr. H. Davis used a 3-inch telescope by the same makers, situated $0^s{\cdot}043$ west and $1''{\cdot}79$ north of the transit instrument; while Dr. Copeland was stationed at the Simms refractor of 6·06 inches aperture and 74·5 inches focus, $0^s{\cdot}023$ west and $0''{\cdot}87$ north of the fundamental point. The time in all cases was derived from the transit-room chronometer, Walker 171, of which the error and rate were determined

every fine night by transits of standard stars. Our best thanks are due to Dr. Pechüle for the communication of the predicted times of many occultations.

Mr. Davis noted the time by his watch, which was usually compared with one of the chronometers used by the other observers within a short time of the occurrence of an occultation. As a check on the deduced times of the phenomena observed, the whole of the chronometer comparisons are recorded in the following table :—

COMPARISONS OF THE TRANSIT ROOM CHRONOMETER 171 WITH THE TIME-KEEPERS USED AT THE EQUATORIALS.

Sidereal Chronometer 41.

1874	(171)	Correction by star-transits	(41)	Correction	Epoch by (41)	Correction	Hourly rate
	h. m. s.	m. s.	h. m. s.	h. m. s.	h. m.	h. m. s.	s.
Nov. 12	23 10 41·0	−1 23·46	23 10 0·0	−0 0 42·46	23 39·0	−0 0 42·50	[−0·2265]
	0 8 40·9	−1 23·44	0 8 0·0	42·54			
	Chronometer 41 ran down in the interim.						
Nov. 13	22 39 30·0	−1 22·97	22 39 44·5	−0 1 37·47	0 47·4	−0 1 37·83	
	2 54 45·0	−1 22·89	2 55 0·3	1 38·19			−0·2265
Nov. 14	23 37 9·5	−1 22·50	23 37 30·0	−0 1 43·00	23 37·5	−0 1 43·00	
	Chronometer 41 again ran down in the interim.						
Nov. 17	22 32 51·0	−1 20·82	22 28 0·0	+0 3 30·18			
	1 14 0·0	−1 20·76	1 9 9·5	3 29·74	0 31·4	+0 3 29·73	
	2 2 0·0	−1 20·74	1 57 10·0	3 29·26			−0·2004
Nov. 19	22 43* 10·0	−1 20·05	22 38 29·5	+0 3 20·45	23 55·2	+0 3 20·23	
	1 16 40·0	−1 19·99	1 12 0·0	3 20·01			−0·1613
Nov. 20	23 3 36·0	−1 19·40	22 59 0·0	+0 3 16·60			
	23 6 36·0	−1 19·40	23 2 0·0	3 16·60	1 5·3	+0 3 16·17	−0·208
	5 19 34·5	−1 19·20	5 15 0·0	3 15·30			

Mean-time Chronometer 31.

1874	(171)	Correction by star-transits	(31)	Correction	Epoch by (31)	Correction	Hourly rate
	h. m. s.	m. s.	h. m. s.	h. m. s.	h. m.	h. m. s.	s.
Nov. 23	1 54 7·0	−1 16·76	5 52 0·0	+3 50 43·13	6 12·0	+3 50 43·07	
	2 34 40·0	−1 16·74	6 32 26·5	43·01			−0·0267
Nov. 24	5 31 36·5	−1 15·85	9 25 0·0	+3 50 42·01	11 0·9	+3 50 42·30	
	8 44 0·0	−1 15·74	12 36 51·5	42·60			−0·0595
Nov. 26	0 12† 32·5	−1 14·37	3 59 0·0	+3 50 39·92			
	0 22 36·0	−1 14·36	4 9 4·0	[37·79]	4 5·5	+3 50 39·86	
	0 25 30·0	−1 14·36	4 11 55·5	39·81			
	5 6 0·0	−1 14·25	7 51 49·5	39·80			
	5 49 57·0	−1 14·19	9 35 30·5	[38·83]			
	5 52 30·0	−1 14·19	9 38 2·0	39·91	8 44·9	+3 50 39·86	
	7 38 9·0	−1 14·14	11 23 25·0	[38·65]			
Dec. 13	0 12‡ 3·0	−1 0·22	2 52 30·5	+3 50 3·61	4 18·4	+3 50 3·48	
	3 4 15·0	−1 0·10	5 44 14·5	3·52			

* 37ᵐ in original. † 7ᵐ in original. ‡ 13ᵐ in original.

Mean-time Pocket-Chronometer. John McLennan, No. 7095.

1874	(171)	Correction by star-transits	McLennan	Correction	Epoch by McLennan	Correction	Hourly rate
	h. m. s.	m. s.	h. m. s.	h. m. s.	h. m.	h. m. s.	s.
Nov. 12	23 4 10·0	−1 23·46	6 52 20·6	+0 44 1·72	7 18·8	+0 44 1·69	
	23 57 10·0	−1 23·44	7 45 12·0	1·66			−0·5754
Nov. 17	0 21 0·0	−1 20·78	7 50 30·4	+0 42 52·45	7 50·9	+0 42 52·34	
	0 21 45·0	−1 20·78	7 51 15·5	52·23			−0·5606
Nov. 20	4 50 45·0	−1 19·21	12 8 27·8	+0 42 9·70			
	5 15 45·0	−1 19·20	12 33* 24·2	9·21	12 40·4	+0 42 9·27	
	6 1 45·0	−1 19·18	13 19 17·0	8·89			
Nov. 23	0 6 10·0	−1 16·82	13 9 2·0	−5 13 58·24			
	1 26 50·0	−1 16·78	14 29 29·8	59·22	14 16·2	−5 13 59·20	−0·8531
	6 5 16·8†	+3 50 43·07	15 10 0·0	60·13			
	Chronometer McLennan ran down in the interim.						
Nov. 24	6 41 9·0	−1 15·81	14 23 24·7	+0 1 38·45	15 28·7	+0 1 37·66	−0·7248
	8 52 9·0	−1 15·73	16 34 4·9	36·87			
	Chronometer McLennan again ran down.						
Nov. 26	2 44 40·0	−1 14·29	6 30 43·9	+3 50 38·68			
	3 57 30·0	−1 14·25	7 43 23·0	37·69	7 7·1	+3 50 38·18	−0·8182

Mr. Davis's Watch.

1874	Chron.	Chronometer-time	Correction by (171)	Watch	Correction	Epoch by watch	Correction	Hourly rate
		h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m.	h. m. s.	s.
Nov. 13	(41)	23 46‡ 41·0	−0 1 37·60	8 19 15·0	−0 4 38·65			−1·17
Nov. 17	(41)	22 55 30·0	+0 3 30·05	7 19 27·0	−0 6 30·10			
	„	0 58 0·0	+0 3 29·64	9 21 39·0§	32·58			
Nov. 23	McL.	13 48 6·6	−5 13 58·80	8 42 30·0	−0 8 22·20			
	„	14 44 57·8	−5 13 59·61	9 39 20·0‖	21·81			
Nov. 24	(31)	10 34 0·0	+3 50 42·32	14 33 45·5	−0 9 3·18			
	McL.	14 27 17·3	+0 1 38·40	14 38 0·0	4·40	14 44·3	−0 9 3·92	
	McL.	14 50 17·6	+0 1 38·12	15 1 0·0	4·28			
	(31)	12 23 30·0	+3 50 42·24	16 23 13·0	0·76			
	McL.	16 16 21·8	+0 1 37·08	16 27 0·0	1·12	16 25·1	−0 9 0·94	
Nov. 26	McL.	[6 40] 30·2	+3 50 38·54	... ... 13·0	−0 0 4·26			
	„	[7 6] 21·8	38·19	... ... 0·0	0·01			
	„	[7 32] 35·8	37·83	... ... 0·0	46·37			
	„	[8 22] 5·8	37·16	... ... 30·0	47·04			
	„	[9 22] 52·2	36·33	... ... 0·0	31·47			
	„	[9 56] 0·0	35·88	... ... 7·2	31·32			
	„	[10 43] 5·5	35·23	... ... 10·0	29·27			
	„	[11 12] 6·5	34·85	... ... 10·0	28·65			

* 32^m in original. † Chronometer 31. ‡ 48^m in original note-book. § $9^s{\cdot}0$ in original.
‖ 30^s in note-book. It seems as if the units of the seconds had been written down at once and the tens added afterwards, often erroneously.

The next table contains the actual observations as they were recorded, unless a note to the contrary is appended. The estimated magnitudes are probably too bright by at least a full magnitude, but may be of use in the satisfactory identification of the stars. The position angles of the stars on the moon's limb were in some cases simply estimated, while in others a rough diagram was made, from which the angle has been taken.

With the aid of the preceding tables the Belmont sidereal times can be readily checked. A current number has been added to facilitate reference. Observations 33 and 34 are extremely discordant without our being able to assign a cause, the figures in the note-books being perfectly distinct, nor does the computation of the longitude decide which is the more trustworthy. The 47th and 52nd observations have evidently been considerably affected by clouds, as noted by the observer.

OCCULTATIONS OF STARS OBSERVED AT BELMONT.

1874	Star's name	Current No.	Mag.	Phen.	Chron.	Chronometer time			Correction			Belmont sidereal time			Observer	Remarks
						h.	m.	s.	h.	m.	s.	h.	m.	s.		
Nov. 12	Anonyma	1	8½	disap.	41	22	32	58·5	−0	0	42·25	22	32	16·25	Ld. L.	Good; instantaneous. ☾'s vertex.
,,	Anonyma	2	8½	disap.	McL.	6	39	21·5	+0	44	2·07	22	49	45·66	R. C.	70° from ☾'s south cusp.
,,	Anonyma	3	7	disap.	41	22	51	24·3	−0	0	42·32	22	50	41·98	Ld. L.	Very good; 60° from *n* cusp.
,,	Anonyma	4	8½	disap.	McL.	6	48	24·0	+0	44	1·98	22	58	49·55	R. C.	90° from cusps.
,,	Anonyma	5	7½	disap.	41	23	0	22·4	−0	0	42·35	22	59	40·05	Ld. L.	Faint; hung on the ☾'s dark limb. 45° *n* of vertex.
,,	Anonyma	6	9	disap.	41	23	20	20·5	−0	0	42·43	23	19	38·07	Ld. L.	45° *n* of vertex; uncertain to 2 secs.
,,	Anonyma	7	7½	disap.	41	23	33	58·0	−0	0	42·48	23	33	15·52	Ld. L.	±1 sec.; flickering.
,,	Anonyma	8	8	disap.	McL.	7	23	18·0	+0	44	1·65	23	33	48·96	R. C.	30° from *n* cusp.
,,	Anonyma	9	8	disap.	McL.	7	24	11·5	+0	44	1·64	23	34	42·59	R. C.	35° from *n* cusp.
,,	Anonyma	10	8	disap.	McL.	7	26	50·2	+0	44	1·61	23	37	21·70	R. C.	90° from cusps.
,,	Anonyma	11	8	disap.	McL.	7	38	29·0	+0	44	1·50	23	49	2·30	R. C.	70° from *s* cusp.
Nov. 13	Anonyma	12	7	disap.	41	22	42	52·4	−0	1	37·36	22	41	15·04	Ld. L.	Very good; 90° from cusps.
,,	Anonyma	13	8	disap.	41	22	48	23·7	−0	1	37·38	22	46	46·32	Ld. L.	Very good; 50° from *n* cusp.
,,	Anonyma	14	7½	disap.	41	23	9	12·0	−0	1	37·46	23	7	34·54	Ld. L.	Good; 50° from *s* cusp.
,,	Stone 10268	15		disap.	41	23	41*	33·4	−0	1	37·58	23	39	55·82	Ld. L.	Very good; 90° from cusps.
,,	,,	16		,,	Watch	8	14	7·0	−0	4	38·55			54·66	H. D.	
,,	A.Ö. 18802	17	7	disap.	41	0	31	18·0	−0	1	37·77	0	29	40·23	Ld. L.	Fair, ±0ˢ·5; 40° from *s* cusp.
,,	Anonyma	18	8	disap.	41	0	40	42·0	−0	1	37·81	0	39	4·19	Ld. L.	Bad, uncertain to 5 secs.; star very faint, the heliometer dome being in the way.
Nov. 17	B.W. xxii. 506	19	7	disap.	41	0	29	51·3	+0	3	29·74	0	33	21·04	Ld. L.	
,,	,,	20		,,	Watch	8	53	36·0	−0	6	32·01			22·60	H. D.	
,,	,,	21	7	,,	McL.	8	4	12·0	+0	42	52·21			22·82	R. C.	$\delta = -14° 16' \pm$.
,,	Anonyma	22	8½	disap.	McL.	8	7	39·5	+0	42	52·18	0	36	50·86	R. C.	Almost exactly following No. 21.

* 43^m in the original note-book.

OCCULTATIONS OF STARS OBSERVED AT BELMONT (*continued*).

1874	Star's name	Current No.	Mag.	Phen.	Chron.	Chronometer time h.	m.	s.	Correction h.	m.	s.	Belmont sidereal time h.	m.	s.	Observer	Remarks
Nov. 20	ζ^1 Piscium	23		disap.	41	5	2	11·5	+0	3	15·34	5	5	26·84	Ld. L.	Reappearance missed in light cloud.
„	„	24		„	McL.	12	24	28·0	+0	42	9·46			28·38	R. C.	Power 180.
„	ζ^2 Piscium	25		disap.	41	5	3	3·2	+0	3	15·34	5	6	18·54	Ld. L.	
„	„	26		„	McL.	12	25	20·2	+0	42	9·45			20·72	R. C.	Power 180.
„	„	27		reap.	McL.	13	7	53·5	+0	42	8·95	5	49	0·50	R. C.	ζ^1 was seen shortly after reappearance.
Nov. 23	36 Tauri	28		disap.	Watch	9	12	4·0	−0	8	22·00	1	13	42·70	H. D.	
„	„	29		„	McL.	14	17	42·0	−5	13	59·22			43·48	R. C.	Disappeared at the roughened terminator, seeming to enter on the moon.
Nov. 24	B.A.C. 1648	30	6	disap.	31	11	17	39·0	+3	50	42·29	7	23	18·44	Ld. L.	Star very faint.
„	„	31		„	Watch	15	17	25·0	−0	9	2·94			19·21	H. D.	
„	„	32		„	McL.	15	6	48·4	+0	1	37·92			23·48	R. C.	Power 370; disappeared in a deep indentation.
„	„	33		reap.	31	12	31	28·0	+3	50	42·24	8	37	19·52	Ld. L.	
„	„	34		„	McL.	16	20*	48·6	+0	1	37·03			34·95	R. C.	Reappeared very suddenly.
Nov. 26	59 Gemin.	35		disap.	Watch			59·0†	−		4·26	2	57	60·25	H. D.	
„	„	36		„	McL.	6	45	11·2	+3	50	38·48			55·18	R. C.	Dawes's solar eyepiece. power 57, field 4′.
„	ι Gemin.	37		disap.	31	7	11	15·0	+3	50	39·86	3	24	4·65	Ld. L.	
„	„	38		„	Watch			52·6	−		0·01			2·37	H. D.	
„	„	39		„	McL.	7	11	18·2*	+3	50	38·12			6·11	R. C.	4′ field.
„	59 Gemin.	40		reap.	31	7	37	25·5	+3	50	39·86	3	50	19·45	Ld. L.	
„	„	41		„	Watch			51·2	−		46·37			18·91	H. D.	
„	„	42		„	McL.	7	37	28·2	+3	50	37·77			20·06	R. C.	Field 6′, reappeared very suddenly.
„	ι Gemin.	43		reap.	31	8	27	13·5	+3	50	39·86	4	40	15·63	Ld. L.	
„	„	44		„	Watch			40·0	−		47·04			15·23	H. D.	
„	„	45		„	McL.	8	27	15·6	+3	50	37·09			14·95	R. C.	Reappeared very suddenly.
„	b^2 Gemin.	46		disap.	31	9	28	3·0	+3	50	39·86	5	41	15·12	Ld. L.	
„	„	47		„	Watch			4·0	−		31·47			4·76	H. D.	Uncertain; through cloud.
„	„	48		„	McL.	9	28	12·5	+3	50	36·26			21·03	R. C.	Through passing clouds, but certain to 1 sec.
„	B.A.C. 2472	49		disap.	McL.	10	0	58·0	+3	50	35·81	6	14	11·46	R. C.	Good.
„	b^2 Gemin.	50		reap.	McL.	10	48	5·5	+3	50	35·17	7	1	26·06	R. C.	Sudden.
„	B.A.C. 2472	51		reap.	31	11	16	35·2	+3	50	39·86	7	30	5·15	Ld. L.	Disappearance lost in cloud.
„	„	52		„	Watch			55·5	−		28·65			16·97	H. D.	Uncertain; through cloud.
„	„	53		„	McL.	11	16	38·0	+3	50	34·78			2·86	R. C.	
Dec. 13	Anonyma	54	7	disap.	31	3	47	55·5	+3	50	3·53	1	6	36·82	Ld. L.	Good; 90° from cusps.

* 21^m in note-book.

† On November 26 the seconds-hand of Mr. Davis's watch was compared with that of the chronometer about 5 minutes before each observation, the seconds only of both timekeepers being noted. The epochs by McLennan have therefore been assumed, but are within 1 or 2 minutes of the truth. Occasionally Mr. Davis recorded the time by arresting the detent-hand of his watch. This operation seems to have interfered with the continuity of the indications of the watch itself; hence it is impossible to make any allowance for rate between each comparison with McLennan and the subsequent observation. The error from this cause, however, cannot exceed $0^s{\cdot}1$. In observing, Mr. Davis practically only noted the seconds of the time of each phenomenon, the minutes being those recorded by the other observers.

Adopted Places of the Moon and Stars.

For the moon's right ascension, the corrections were adopted which have already been deduced in the case of the moon-culminations. For the declinations of the moon, all the available observations from November 14 to November 30 were reduced to the system of declinations represented by the second Greenwich 7-year catalogue for 1864·0. To effect this, the Greenwich observations were corrected by the table at p. 27 of the 9-year catalogue. The Washington declinations of November 16 and November 21 were modified to the extent of $-0''\cdot22$ and $0''\cdot00$ respectively, in accordance with Boss. The Oxford results were changed to the extent of the difference between Boss's corrections for Radcliffe 1873 and the second Greenwich 7-year catalogue; or by $-0''\cdot25$, $-0''\cdot02$ and $-0''\cdot19$. The Leyden results, based on Auwers's list, were amended in the same way by the differences between Boss ('64 cat.[1]) and Auwers-Boss.[2] The systematic corrections given by Downing ('Monthly Notices,' vol. xlii. p. 23) were applied to the observations made at the Cape of Good Hope. The Paris observations alone were used unchanged, the mean of both instruments being taken whenever two were used.

In the table below, the initials of the observatories have the same significations as before. For Greenwich and Oxford the ephemeris for the transit of the moon's limb was corrected for the small difference between the tabular epoch and the actual time of transit, as already explained

Corrections in declination to the Hourly Ephemeris of the 'Nautical Almanac,' derived from Hansen's 'Tables de la Lune,' afforded by Observations compared with a Curve showing the Mean Correction.

Date and Observatory	Reduction of observation to 2nd 7-yr. cat.	Correction by		C–O	Newcomb	Date and Observatory	Reduction of observation to 2nd 7-yr. cat.	Correction by		C–O	Newcomb
		Obs.	Curve					Obs.	Curve		
G. M. T. 1874						G. M. T. 1874					
Nov. 14·17 P.	0″·00	−4″·24	−2″·4	+1″·8	−1″·1	Nov. 21·41 L.	+0″·09	−4″·10	−3″·4	+0″·7	−4″·7
16·23 L.	+0·34	−2·17	−3·2	−1·0	−2·8	21·41 P.	0·00	−3·68	−3·4	+0·3	−4·7
16·47 W.	−0·22	−2·92	−3·3	−0·4	−3·0	21·64 W.	0·00	−4·40	−3·2	+1·2	−4·6
17·23 C.	−0·04	−2·45	−3·5	−1·0	−3·5	22·41 C.	−0·44	−4·16	−2·5	+1·7	−4·2
17·27 L.	+0·36	−2·93	−3·5	−0·6	−3·5	22·46 G.	−0·70	−4·33	−2·5	+1·8	−4·2
17·28 G.	−1·17	−5·65	−3·5	+2·1	−3·5	23·49 L.	−0·08	−0·15	−1·1	−1·0	−3·2
18·26 C.	−0·08	−2·98	−3·7	−0·7	−4·2	23·49 P.	0·00	−1·83	−1·1	+0·7	−3·2
18·32 O.	−0·25	−4·57	−3·7	+0·9	−4·2	23·50 G.	−0·67	−0·57	−1·0	−0·4	−3·2
19·30 C.	−0·09	−2·59	−3·8	−1·2	−4·6	23·50 O.	−0·19	−0·42	−1·0	−0·6	−3·2
19·34 P.	0·00	−2·55	−3·8	−1·2	−4·6	24·53 L.	−0·08	−0·12	+0·3	+0·4	−1·9
19·35 G.	−0·90	−5·47	−3·8	+1·6	−4·6	25·58 P.	0·00	−1·54	+1·9	+3·4	−0·2
19·35 O.	−0·02	+0·78	−3·8	−4·6	−4·6	26·62 L.	−0·08	+3·33	+3·6	+0·3	+1·5
20·33 C.	−0·15	−2·05	−3·8	−1·7	−4·8	26·63 G.	−0·65	+5·15	+3·6	−1·5	+1·5
20·38 G.	−0·81	−1·77	−3·8	−2·0	−4·8	27·66 L.	−0·08	+4·55	+4·7	+0·1	+2·9
21·37 C.	−0·30	−6·26	−3·4	+2·9	−4·7	30·76 L.	+0·13	+5·53	+5·0	−0·5	+5·1

[1] Boss: *Declinations of Fixed Stars*, p. 586.

[2] *Memoirs of the American Academy*, vol. x. p. 405.

on p. 473. Professor Newcomb's corrections are again inserted for comparison. The correction for the moon's declination was taken from the curve for the epoch of each occultation excepting on two occasions—firstly, for the two small stars (occultations 2 and 8), for which the 'Nautical Almanac' was considered correct, Newcomb's curve crossing the zero line at that epoch, and there being no meridian observations on that day; secondly, for the solitary occultation (54) on December 13, for which again Newcomb's correction was adopted.

MEAN PLACES OF STARS OCCULTED AT BELMONT. (WHEN THE PLACE IS NOT GIVEN TO FRACTIONS OF A SECOND IT IS ONLY ROUGHLY APPROXIMATE.)

Star's name	No. of occult.	Mag.	A.R., 1874·0			Decl., 1874·0			Remarks and systematic reductions to the second Greenwich 7-year catalogue
			h.	m.	s.	°	′	″	
Anonyma	1	8·3	17	46	42	−27	56·4		
Anonyma	2	7·4	17	47	16·53	−27	58	40·3	Dunsink obs. −0ˢ·05, +0″·3.
Anonyma	3	8·0	17	47	25	−27	46·3		
Anonyma	4	8·5	17	47	42	−27	52·8		Very uncertain.
Anonyma	5	8·6	17	47	42	−27	47·0		
Anonyma	6	9·0	17	48	26	−27	45		Very uncertain.
Anonyma	7								Not identified.
Anonyma	8	8	17	48	37·07	−27	37	8·0	Dunsink obs. −0ˢ·04, +0″·1.
Anonyma	9	8	17	48	41	−27	37·8		2nd of two stars.
Anonyma	10	8	17	49	23	−27	46		Somewhat uncertain.
Anonyma	11	8	17	49	5	−27	53·4		
Anonyma	12	10	18	43	17	−28	3	40	
Anonyma	13	10	18	43	16·4	−27	51	22	
Anonyma	14	10	18	43	50	−28	8		
Stone 10268	15 &c.	7	18	45	13·42	−27	54	24·6	½ (Stone, 0ˢ·00, +0″·1, + Yarnall, 0ˢ·00, −0″·5). Arg. Ö. is 1′ too far north.
A.Ö. 18802	17	9	18	46	32·28	−27	59	10·9	Yarnall, 0ˢ·00, −0″·5.
Anonyma	18	10	18	47	19	−27	48	47	
B.W. xxii, 506	19 &c.		22	25	26·12	−14	14	31·9	⅓ (B.W. + 3 Bonn Obs. vi. −0ˢ·07, −0″·6, + 3 Dun Echt obs. −0ˢ·06 + 0″·3).
Anonyma	22		22	25	29·06	−14	14	35·3	2ˢ·94 *f* and 3″·35 *s* of the foregoing. Dun Echt obs. 1879 xii. 8 and 1884 viii.
ζ^1 Piscium	23 &c.		1	7	8·91	+ 6	54	30·5	Newcomb, −0ˢ·04, 0″·0.
ζ^2 Piscium	25 &c.		1	7	10·31	+ 6	54	40·8	1ˢ·405 *f* and 10″·34 *n* of the foregoing by measures of Struve, Mädler, Fletcher, &c.
36 Tauri	28 &c.		3	56	49·66	+23	45	25·0	Newcomb, −0ˢ·03, −0″·1.
B.A.C. 1648	30 &c.		5	13	4·79	+27	49	37·5	Greenwich 9-year cat., 0ˢ·00, −0″·5.
59 Gemin.	35 &c.		7	16	42·94	+27	52	44·8	Newcomb, −0ˢ·02, −0″·1.
ι Gemin.	37 &c.		7	17	53·94	+28	2	46·5	Newcomb, −0ˢ·02, −0″·1.
b^3 Gemin.	46 &c.		7	21	58·44	+28	10	25·7	Newcomb, −0ˢ·02, −0″·1.
B.A.C. 2472	49 &c.		7	22	49·41	+28	10	10·9	Newcomb, −0ˢ·02, −0″·1.
Anonyma	54	9	21	17	6·52	−20	19	55·8	J. G. Lohse, 1884 viii. 2, 51ˢ·843 *f* and 6′ 54″·51 *s* of Bonn Obs. vi. p. 363, zone −14° 40′ to −31° 20′, xxi.ʰ, No. 23, −0ˢ·08, −0″·6.

Roughly approximate places of some of the stars occulted on November 12 and 13 were obtained with the Dun Echt equatorial; but that part of the heavens is so nearly inaccessible at Dun Echt, that it is only on rare occasions that even the most imperfect survey can be

made, and then only in strong twilight during the summer nights. For somewhat better places of stars 2 and 8, we are indebted to Dr. Dreyer, who kindly secured observations at the rather more favourably situated observatory of Dunsink. The other stars were taken from the catalogues indicated, but in each case small corrections were applied to reduce the places to the Greenwich system of the second 7-year catalogue. These were derived from the investigations of Argelander, Newcomb, Boss, Rogers and Downing, or, in the case where Auwers's Fundamental Catalogue formed the basis of observations, from a direct comparison of his right ascensions with those of the Greenwich Clock List for 1875.

The reduction of the stars to apparent place was made with the data of the 'Nautical Almanac.' The longitude was then computed from each available observation by Bessel's method adapted to the formulæ and notation used by Professor Börgen ('Copernicus,' vol. i. p. 8 *et seq.*), in which—

t=observed mean time of the observed phenomenon—*e.g.* disappearance.
θ=observed sidereal ,, ,, ,, ,, ,, ,, ,,
$T=t+d$=approximate Greenwich mean time.
α, δ=R.A. and declination of the moon.
α^*, δ^*=R.A. and declination of the star.
π=the moon's horizontal equatorial parallax.
$\log k$=9·435590 (from Oudemans' paper in '*Ast. Nach.*,' No. 1202), or mean radius of moon=0·27264 earth's equatorial radius.
ρ, ϕ'=radius and geocentric latitude of the place of observation.

$\left.\begin{matrix}\xi,\ \eta\\ x_o,\ y_o\end{matrix}\right\}$ co-ordinates at the time T $\begin{cases}\text{of the place of observation.}\\ \text{of the moon.}\end{cases}$

x', y'=first differential quotients of the moon's co-ordinates, or their changes in one hour.

The requisite computations are :—

(1)
$$\xi=\rho\cos\phi'\sin(\theta-\alpha^*)$$
$$\eta=\rho\sin\phi'\cos\delta^*-\rho\cos\phi'\sin\delta^*\cos(\theta-\alpha^*).$$

(2) For three full hours of Greenwich time

$$x=\frac{\cos\delta\sin(\alpha-\alpha^*)}{\sin\pi}$$
$$y=\frac{\sin\delta\cos\delta^*-\cos\delta\sin\delta^*\cos(\alpha-\alpha^*)}{\sin\pi}.$$

(3) The values of x_o, y_o, x' and y' are then to be interpolated for the time T, with which to compute m, M, n and N from :—

(4)
$$x_o-\xi=m\sin M \quad \text{and} \quad x'=n\sin N$$
$$y_o-\eta=m\cos M \quad \text{and} \quad y'=n\cos N$$
$$m\sin(M-N)=k\sin\psi,$$

then the true difference of longitude from Greenwich is :—

(5)

$$d_o = t - T + \frac{m}{n} \cdot \frac{\sin(M-N+\psi)}{\sin\psi}\ 3600^s + \frac{h\cos\delta\sin(N-\psi)}{\cos\psi}\Delta(\alpha-\alpha^*) + \frac{h\cos(N-\psi)}{\cos\psi}\Delta(\delta-\delta^*)$$

where

$$h = \frac{3600^s}{206264{\cdot}8\ n\sin\pi}.$$

In the formula

$$y\sin\pi = \cos\delta^*\{\sin\delta - \cos\delta\tan\delta^*\cos(\alpha-\alpha^*)\}$$

Professor Börgen sets

(6) $$\tan\delta^*\cos(\alpha-\alpha^*) = \tan(\delta^*-\gamma),$$

then

$$y\sin\pi = \cos\delta^*\left\{\sin\delta - \cos\delta\frac{\sin(\delta^*-\gamma)}{\cos(\delta^*-\gamma)}\right\} = \sin(\delta-\delta^*+\gamma)\frac{\cos\delta^*}{\cos(\delta^*-\gamma)},$$

or

(7) $$y = \frac{\sin(\delta-\delta^*+\gamma)}{\sin\pi}\cdot\frac{\cos\delta^*}{\cos(\delta^*-\gamma)}.$$

In the paper referred to will be found tables for both γ and log cos δ^* sec $(\delta^*-\gamma)$, but, in practice, we have found the indirect computation of γ from (6), and thence the logarithm of the second part of (7), quite as simple as the use of the most extended tables. To effect this it is only necessary to take out the differences of log tan δ^* and log cos δ^*, each for $\frac{100''}{100}$, from the ordinary tables. Then the division of log sec $(\alpha-\alpha^*)$ by the former gives γ, and γ, multiplied by the latter, affords the complement of log cos δ^* sec $(\delta^*-\gamma)$, which is always subtractive from the sum of the other logarithms. γ has always the same sign as the declination of the star, and has to be applied with this sign to the difference $(\delta-\delta^*)$. For example, on December 13, 1874, the computation of the values of y takes the form—

G.M.T.	3^h	4^h	5^h	
$\delta-\delta^*$	$-0^\circ\ 25'\ 51''{\cdot}5$	$-0^\circ\ 14'\ 52''{\cdot}9$	$-0^\circ\ 3'\ 47''{\cdot}5$	
$\alpha-\alpha^*$	$+0^\circ\ 8'\ 40''{\cdot}95$	$+0^\circ\ 41'\ 43''{\cdot}05$	$+1^\circ\ 14'\ 41''{\cdot}85$	$\delta^* = -20^\circ\ 19'\ 53''{\cdot}5$
log sec $(\alpha-\alpha^*)$	0·0000014	320	1025	Δ log tan $\delta^* = -64{\cdot}6$ (7th place)
γ	$-0''{\cdot}22$	$-4''{\cdot}95$	$-15''{\cdot}86$	
log sin $(\delta-\delta^*+\gamma)$	$7{\cdot}876384_n$	$7{\cdot}638777_n$	$7{\cdot}071824_n$	
log cosec π	1·780664	1·780490	1·780316	
colog $\frac{\cos\delta^*}{\cos(\delta^*-\gamma)}$	0	−4	−12	Δ log cos $\delta^* = -0{\cdot}78$ (6th place)
log y	$9{\cdot}657048_n$	$9{\cdot}419263_n$	8·852128	

In the computation of ξ and η we have used the same latitude, $-20^\circ\ 2'\ 56''{\cdot}0$, for all the telescopes; this, combined with Bessel's dimensions of the earth, gives

$$\phi' = -19^\circ\ 55'\ 32''{\cdot}3,\ \log\rho\sin\phi' = 9{\cdot}532330_n,\ \text{and}\ \log\rho\cos\phi' = 9{\cdot}973021.$$

Any modification of these values to suit the positions of the different observers would correspond to a displacement of the moon of less than 0″·02.

The resulting longitudes thus deduced differ very much in their trustworthiness. Apart from other considerations, they are greatly dependent on the position of the star with regard to the apparent path of the moon's centre, as well as the velocity of the moon's apparent motion. This is best shown by the differential factors for the relative right ascensions and declinations of the moon and each star, which can therefore be used in the formation of weights. But here there is the difference that, while the factors for $\Delta\alpha$ are practically all positive, those for $\Delta\delta$ vary in sign; and in cases where both disappearance and reappearance of the same star have been observed, the factors for $\Delta\delta$ have usually opposite signs for the two phenomena. If, therefore, we give to each observation a weight inversely as the sum of the squares of the right ascension and declination factors, it becomes necessary, whenever both phases have been secured, to omit the smaller declination factor for the one phenomenon, and use only the difference of the two declination factors in combination with the $\Delta\alpha$ factor for the other—*e.g.* for the disappearance and reappearance of ζ^2 Piscium the coefficients of $15\Delta(\alpha-\alpha^*)$ are +2·189 and +0·490, while those for $\Delta(\delta-\delta^*)$ are −0·732 and +2·540; the weight for the disappearance will therefore be

$$\frac{1}{2\cdot189^2} = 0\cdot2087,$$

and that for the reappearance

$$\frac{1}{0\cdot490^2+(2\cdot540-0\cdot732)^2} = 0\cdot2850.$$

To allow for the inferior optical power of the 3-inch telescope, observations made with it have received single weight, while double weight has been given to those with the other instruments. In this way the weights p in the succeeding table have been computed. The other columns sufficiently explain themselves. In observations of this class, where considerable errors may arise through the sudden intervention of clouds and from other causes, the great support which a corroborative record affords seems to entitle each single observation to full weight in the result. The longitude derived from each observation is therefore separately entered in the table.

A number of occultations of small stars on November 12 and 13 have not been computed at all, for want of the places of the stars; but, from the certainty with which the disappearances could be observed at the moon's so-called dark limb, which was, however, beautifully illuminated by earth-light, it is probable that the whole of the occultations on those days will afford very exact places of the moon whenever accurate positions of these stars shall become available. Owing to the uncertainty of the positions of both moon and stars, occultations 2 and 8 are, for the present, also excluded in the deduction of the longitude, as well as numbers 47 and 52, on account of their uncertainty. Number 27 is widely discordant, although the observation is believed to be fairly accurate, as the observer's attention was directed, by the aid of ζ^1 Piscium, to the exact part of the moon's limb where the companion star was about to reappear. All the phenomena on that day, however, agree in making the longitude rather large. The two records for the reappearance of B.A.C. 1648 cannot be reconciled, but since their mean agrees closely with the final longitude, the only effect of retaining them is to increase the probable

REDUCTION OF OCCULTATIONS.

No.	Date, 1874	Star's name	Star's apparent place		Reduction from 1874·0		Correction to ☾'s place (N.A.)		Resulting longitude, east	Factor for $15\Delta(\alpha-\alpha^{\odot})$	Factor for $\Delta(\delta-\delta^{*})$	Weight p.
			A.R.	Decl.								
			h. m. s.	° ′ ″	s.	″	s.	″	h. m. s.			
2	Nov. 12	Anonyma *d*	17 47 17·92	−27 58 49·9	+1·39	− 9·6	−0·36	0·0	3 50 53·8	+1·672	−1·022	[0·5208]
8	,,	Anonyma *d*	17 48 38·46	−27 37 17·4	+1·39	− 9·4	,,	,,	32·7	+1·867	+2·401	[0·2162]
15	Nov. 13	Stone 10268 *d*	18 45 15·11	−27 54 32·2	+1·69	− 7·6	−0·36	0·0	36·8	+1·711	−0·124	0·6796
16	,,	,,	,,	,,	,,	,,	,,	,,	35·8	,,	,,	0·3398
17	,,	A.Ö. 18802 *d*	18 46 33·98	−27 59 18·5	+1·70	− 7·6	,,	,,	43·5	+1·847	−2·908	0·1684
19	Nov. 17	B.W. xxii. 506 *d*	22 25 28·75	−14 14 22·4	+2·63	+ 9·5	−0·36	−3·5	39·7	+2·209	−0·767	0·3658
20	,,	,,	,,	,,	,,	,,	,,	,,	40·5	,,	,,	0·1829
21	,,	,,	,,	,,	,,	,,	,,	,,	40·7	,,	,,	0·3658
22	,,	Anonyma *d*	22 25 31·69	−14 14 25·8	+2·63	+ 9·5	,,	,,	43·9	+2·302	−0·976	0·3198
23	Nov. 20	ζ^{1} Piscium *d*	1 7 12·09	+ 6 54 52·6	+3·18	+22·1	−0·44	−3·9	41·9	+2·183	−0·722	0·3782
24	,,	,,	,,	,,	,,	,,	,,	,,	43·1	,,	,,	0·3782
25	,,	ζ^{2} Piscium *d*	1 7 13·49	+ 6 55 2·9	+3·18	+22·1	,,	,,	42·0	+2·189	−0·732	0·4174
26	,,	,,	,,	,,	,,	,,	,,	,,	43·7	,,	,,	0·4174
27	,,	ζ^{2} Piscium *r*	1 7 13·49	+ 6 55 2·9	+3·18	+22·1	,,	,,	50·5	+0·490	+2·540	0·5700
28	Nov. 23	36 Tauri *d*	3 56 53·62	+23 45 43·6	+3·96	+18·6	−0·70	−1·9	39·5	+1·845	−1·235	0·2029
29	,,	,,	,,	,,	,,	,,	,,	,,	39·9	,,	,,	0·4058
30	Nov. 24	B.A.C. 1648 *d*	5 13 8·99	+27 49 49·4	+4·20	+11·9	−0·83	+0·3	35·3	+1·518	−0·504	0·8680
31	,,	,,	,,	,,	,,	,,	,,	,,	36·0	,,	,,	0·4340
32	,,	,,	,,	,,	,,	,,	,,	,,	38·9	,,	,,	0·8680
33	,,	B.A.C. 1648 *r*	,,	,,	,,	,,	,,	,,	33·7	+1·396	+0·510	1·0262
34	,,	,,	,,	,,	,,	,,	,,	,,	44·5	,,	,,	1·0262
35	Nov. 26	59 Gemin. *d*	7 16 46·93	+27 52 44·2	+3·99	− 0·6	−0·96	+3·1	32·7	+1·395	−1·290	0·5139
36	,,	,,	,,	,,	,,	,,	,,	,,	29·2	,,	,,	1·0278
37	,,	ι Gemin. *d*	7 17 57·93	+28 2 45·6	+3·99	− 0·9	,,	+3·1	39·2	+1·521	−0·110	0·8646
38	,,	,,	,,	,,	,,	,,	,,	,,	37·5	,,	,,	0·4323
39	,,	,,	,,	,,	,,	,,	,,	,,	40·3	,,	,,	0·8646
40	,,	59 Gemin. *r*	7 16 46·93	+27 52 44·2	+3·99	− 0·6	,,	+3·2	38·9	+1·750	+2·066	0·5458
41	,,	,,	,,	,,	,,	,,	,,	,,	38·4	,,	,,	0·2729
42	,,	,,	,,	,,	,,	,,	,,	,,	39·4	,,	,,	0·5458
43	,,	ι Gemin. *r*	7 17 57·93	+28 2 45·6	+3·99	− 0·9	,,	+3·2	40·7	+1·561	+0·241	0·8150
44	,,	,,	,,	,,	,,	,,	,,	,,	40·4	,,	,,	0·4075
45	,,	,,	,,	,,	,,	,,	,,	,,	40·2	,,	,,	0·8150
46	,,	b^{2} Gemin. *d*	7 22 2·42	+28 10 24·5	+3·98	− 1·2	,,	+3·2	37·7	+1·628	+0·759	0·7548
47	,,	,,	,,	,,	,,	,,	,,	,,	(31·2)	,,	,,	...
48	,,	,,	,,	,,	,,	,,	,,	,,	41·5	,,	,,	0·7548
49	,,	B.A.C. 2472 *d*	7 22 53·39	+28 10 9·5	+3·98	− 1·4	,,	+3·3	40·3	+1·648	+0·897	0·7364
50	,,	b^{2} Gemin. *r*	7 22 2·42	+28 10 24·5	+3·98	− 1·2	,,	+3·4	37·9	+1·404	−1·209	0·9200
51	,,	B.A.C. 2472 *r*	7 22 53·39	+28 10 9·5	+3·98	− 1·4	,,	+3·4	44·2	+1·359	−1·593	0·8580
52	,,	,,	,,	,,	,,	,,	,,	,,	(51·6)	,,	,,	...
53	,,	,,	,,	,,	,,	,,	,,	,,	42·8	,,	,,	0·8580
54	Dec. 13	Anonyma *d*	21 17 8·62	−20 19 53·5	+2·10	+ 2·3	−0·50	−2·5	40·8	+1·447	+1·117	0·8542

error of the result. In this way there remain thirty-seven observations of nineteen phenomena, which, combined by the method of least squares, give—

	h.	m.	s.		s.	
Belmont, east of Greenwich . . .	3	50	39·45	±	0·46	; $p=22{\cdot}26$

The probable error of the result from a single phenomenon of weight 1 is $\pm 2^{s}{\cdot}18$.

If we restrict ourselves to those stars, six in number, of which both the disappearances and reappearances were observed, the resulting longitude is $3^{h}\ 50^{m}\ 39^{s}{\cdot}35 \pm 0^{s}{\cdot}90$, or practically the same as before, except that the probable error is larger. But, if the disappearances are separated from the reappearances, we obtain two strikingly discordant results, viz.—

	h.	m.	s.	s.
From the disappearances of 6 stars	L=3	50	37·42	±1·22
From the reappearances of the same 6 stars	L=3	50	41·26	±1·17

These quantities differ even more than the longitudes afforded by transits of the moon's separate limbs, which were $3^{h}\ 50^{m}\ 41^{s}{\cdot}0$ by the first limb, and $3^{h}\ 50^{m}\ 44^{s}{\cdot}2$ by the second limb.

If, again, the occultations before full moon, ingresses as well as egresses, are compared with those in the second half of the lunation, we have—

	h.	m.	s.	
From occultations before full moon	L=3	50	41·53	; $p=6{\cdot}05$
„ „ after „	L=3	50	38·67	; $p=16{\cdot}21$

A similar discordance arises if all the reappearances are classed together as having been observed at the moon's first limb, and the disappearances at her second limb; these give—

	h.	m.	s.
Occultation reappearances (limb I.)	L=3	50	40·89
„ disappearances (limb II.)	L=3	50	38·52

Assuming that the aggregate of all the meridian observations of the moon at fixed observatories really afford places of our satellite considerably more exact than are indicated by the above discordances, we are reduced to the conclusion that these latter arise mainly from inaccuracies in the Belmont observations. Nor is it at all difficult to indicate what seem to be the more faulty members of the series, for occultation phenomena divide themselves naturally into two classes, which may be called the *instantaneous* and the *gradual*. The instantaneous phenomena usually include all ingresses and egresses at the moon's dark limb, as well as all occultations of very bright stars. To the *gradual* class must be relegated the disappearances and reappearances at the moon's bright limb of all stars except the very bright ones already included in the former class. Observations of this second class are subject to many of the difficulties and errors, personal and instrumental, that affect moon culminations and lunar distances measured with a sextant or heliometer. The *instantaneous* phenomena, on the other hand, are probably amongst the most accurate observations that it is possible to make. But in the case of a reappearance, even of a bright star, at the moon's dark limb, it is absolutely necessary to direct the attention to the immediate neighbourhood of the spot where the star must reappear. For, if the star emerges at some distance from the centre of the field of distinct vision, it may possibly remain unnoticed until the eye is accidentally directed towards it, when the very act of perception may be so instantaneous as to simulate completely the

appearance of a sudden egress from behind the darkened moon. Apart from downright mistakes in recording the time, it is doubtful if there exists a more dangerous source of error in observing occultations than that just mentioned.

If, in accordance with this view, only the phenomena satisfactorily observed at the moon's dark limb are taken into account, the very discordant and incompatible reappearances of B.A.C. 1648 being excluded, there remain the following twenty-one observations of eleven occultations, viz. :—

Disappearances at the dark (second) limb,

Nos. 15, 16; 17; 19, 20, 21; 22; 23, 24; 25, 26; and 54,

affording a longitude of $3^h\ 50^m\ 40^s{\cdot}41$.

Reappearances at the dark (first) limb,

Nos. 40, 41, 42; 43, 44, 45; 50; 51 and 53,

with a resulting longitude of $3^h\ 50^m\ 40^s{\cdot}76$.

The close agreement of these results makes it probable that their mean value,

$$L = 3^h\ 50^m\ 40^s{\cdot}60 \pm 0^s{\cdot}33,$$

is as reliable a longitude for Belmont as the foregoing occultations can afford. This combination seems also to be the only one in which the reappearances and disappearances accord within reasonable limits.

Finally, if to this result we give double the weight of that from the mean of the culminations of both limbs of the moon (p. 477), we obtain the

	h.	m.	s.	
Longitude of Belmont from observations of the moon .	= 3	50	41·27	East.

CHAPTER XXIII.

RÉSUMÉ OF THE LATITUDES AND LONGITUDES, WITH DEFINITIONS OF THE STATIONS.

We shall now collect the various values of latitude and longitude deduced in the foregoing chapters, taking advantage of the opportunity to correct certain small errors and misprints which have been discovered during the progress of the volume through the press. The longitudes of the western stations have also been extended to three places of decimals, chiefly because the longitude of the Berlin instrument ends in a 5 of the third place. A few well-determined data from other sources have been added, as well as any particulars that may aid in the future identification of the stations.

Berlin.

Latitude 52° 30′ 16″·7 N.; longitude $0^h\ 53^m\ 34^s{\cdot}91$ east of Greenwich. *Berliner Jahrbuch*, 1883, pp. 368 and 369.

According to a letter from Professor Foerster, Director of the Berlin Observatory, this is the position of the central tower of the observatory. The meridian instrument used in the longitude determinations is $0^s{\cdot}045$ to the westward. (See 'Bestimmung der Längendifferenz zwischen Berlin und Wien.' 4to. Leipzig, 1871.) It will be necessary to apply this difference to the longitudes of Malta and Alexandria from Berlin to refer them to the central tower of the Berlin Observatory.

Malta.

Dr. Löw's station at Malta was at the telegraph office, at the point where Professor Hall observed in 1870. As Dr. Löw did not measure the latitude, Professor Hall's result of

$$\phi = +35^\circ\ 54'\ 11'',$$

based on twenty altitudes of the sun measured with a sextant, has been adopted. (See 'Washington Observations, 1869,' Appendix I.—Reports on Observations of the Total Solar Eclipse of December 22, 1870, pp. 39 and 70.) At the latter place the station is defined as 'on the flat roof of the telegraph office, which, according to the Ordnance Survey Map, on a scale of 1 to 2,500, is 6,040 feet north and 760 feet east of Spencer's monument.'

From the operations detailed in Chapter XVII. we have :—

	h.	m.	s.
Malta east of Berlin, by direct determination (p. 386)	0	4	28·316
By difference of Berlin-Alexandria and Malta-Alexandria (see next page) .	0	4	28·296

Giving the first of these double weight, we may adopt as final :—

	h.	m.	s.
Malta (telegraph office) east of Berlin Transit Circle	0	4	28·309
Reduction to central tower of Berlin Observatory			−·045

Or—

	h.	m.	s.
Malta east of Berlin Observatory (central tower)	0	4	28·264

Or, finally—

	h.	m.	s.
Malta east of Greenwich	0	58	3·174

Alexandria.

The observations were made on the roof of the Hôtel de l'Europe, which was the station previously occupied by Mr. Samuel Hunter. In the 'Account of Observations of the Transit of Venus, 1874, December 8' (4to.), p. 321, the station is thus described:—'The walls of the Hôtel de l'Europe are 2 feet 3 inches thick, and just over the intersection of two partition walls of the same thickness the transit pier was erected.' In Chapter XVI., however, we have seen that the foundation was appreciably unsteady.

In the new edition of the Admiralty Chart, on a scale of 1 to 18,200, with corrections to May 1882, the centre of the Hôtel de l'Europe is laid down 990 feet north and 8,874 feet east of the lighthouse on Eunostos Point; it is also 5,809 feet south and 1,853 feet east of the Pharos Tower, and, lastly, 5,339 feet north by 1,532 feet west of Pompey's Pillar.

From the site occupied by the altazimuth, Mr. Gill made the following readings of the horizontal circle of his instrument when it was directed to the points mentioned :—

	°	′	″
Mosque (low and small, top only visible)	8	42	36·4
Staff of Fort Caffarelli	32	57	6·4
Mosque	65	27	11·4
Magazine	134	7	28·4
Spire of Scotch Church	237	49	25·0
Koptic Church	242	38	48·8

The result arrived at on p. 348 is :—

	h.	m.	s.
Alexandria east of Berlin Transit Circle[1]	1	5	58·942[1]

Therefore

	h.	m.	s.
Alexandria (Hôtel de l'Europe) east of Berlin Observatory (central tower)	1	5	58·897
Alexandria east of Greenwich[2]	1	59	33·807

At p. 319 we also found :—

	h.	m.	s.
Alexandria east of Malta (telegraph office)	1	1	30·646

as the final result from the observations in Chapters XVI. and XVII.

[1] The results Berlin-Alexandria $= 1^h\ 5^m\ 58^s{\cdot}75$ (p. 346) and $1^h\ 5^m\ 58^s{\cdot}65$ (p. 393), are to be considered as merely confirmatory of the above result.

[2] Mr. Hunter's direct result is $1^h\ 59^m\ 33^s{\cdot}69$; see *Account of Observations of the Transit of Venus, &c.*, p. 330.

It will be clearly understood that the partial results Alexandria-Malta = $1^h\ 1^m\ 30^s{\cdot}668$ at p. 348, and Malta-Berlin = $0^h\ 4^m\ 28^s{\cdot}274$ at p. 392, are both affected by the undetermined error of the chronometer at Malta on March 13, but of course in opposite directions. Hence, although their sum gives a reliable longitude of Alexandria, we are not entitled to use either of them separately.

The latitude of the Hôtel de l'Europe, as determined with the altazimuth by Mr. Gill (see p. 460), is :—

$$+31^\circ\ 11'\ 50''{\cdot}71 \pm 0''{\cdot}23.$$

Suez.

Lord Lindsay's station at which Mr. Gill observed is identical with Dr. Löw's. It is in the courtyard of the Austrian consulate.

Mr. Hunter's station, at which he observed the transit of Venus, is at the 'Khedive's Chalet.' Mr. Hunter's station was used by the members of the Great Trigonometrical Survey of India in finding the longitude of Bombay. In the General Report of that survey for 1876–77, p. 55—*a*, we find the following particulars given by Major Campbell, R.E. :—

'*At Suez.*—The pillars used for the longitude observations in connection with Lord Lindsay's Transit of Venus expedition of 1874, were found by traverse to be $0^s{\cdot}025$ west and $23''$ south of our longitude station. Whence their longitude = $2^h\ 10^m\ 13^s{\cdot}212$,[1] and latitude (approximate) $29^\circ\ 57'\ 56''$.'

At p. 45—*a* of the same Report, the observer remarks respecting the foundation :—'Our station at Suez had one objection, arising from the fact of the mound having originally been artificial, though I believe of somewhat ancient date, in consequence of which the foundation of the piers was faulty. This showed itself distinctly in the levelling, which proved that settlement was going on from day to day throughout the observations, and I am sorry to say that the azimuth observations show the same, which affords reason to fear that our results may have somewhat suffered from this cause.'

At p. 333 of the 'Account . . . of the Transit of Venus' Mr. Hunter also complains of 'the looseness of the soil, causing the level readings to vary a good deal.' On account of the low altitude of the sun at the beginning of the transit, Mr. Hunter was induced to choose this somewhat elevated site, but its use in the longitude operations is probably the cause of part at least of the discrepancies between the results for this station and those at the Austrian Consulate.

If, in accordance with the conclusions on p. 433 of this volume, we apply $-0^s{\cdot}016$ to the result at p. 261, we obtain :—

	h.	m.	s.
Suez (Lord Lindsay's station) east of Alexandria . .	0	10	38·923

Or—

	h.	m.	s.
Suez (Lord Lindsay's station) east of Greenwich . .	2	10	12·730

[1] The longitude of Mr. Hunter's station adopted by the G. T. S. of India is therefore $2^h\ 10^m\ 13^s{\cdot}237$; that subsequently given in the *Account*, p. 346, is $2^h\ 10^m\ 13^s{\cdot}17$. This station was 4,437 yards north of the Southern Mole, at the entrance of the Maritime Canal.

In Chapter XV. it has been seen that Mr. Gill made Mr. Hunter's station $0^s{\cdot}32$ east of his own point of observation at the Austrian Consulate. Using this value, the discrepancy between the two final results for the longitude of Suez referred to one point is reduced to $0^s{\cdot}12$, but if the traverse by the members of the Indian Survey is employed it rises to $0^s{\cdot}415$, Mr. Hunter's longitude being the greater in both cases.

The latitude of Lord Lindsay's station is

$$+29^\circ\ 57'\ 59''{\cdot}05 \pm 0''{\cdot}49$$

as found by Mr. Gill with the altazimuth (see p. 460).

Aden.

Lord Lindsay's longitude station was at Aden New Town, about seven-eighths of a mile east of Steamer Point. It is most completely defined by a triangulation instituted by Major Campbell, R.E., of which the results are published in the 'General Report . . . of the Great Trigonometrical Survey of India during 1876–77' at p. 55—*a*, and also in the Appendix to Part II. of the 'Account of the Operations of the G. T. Survey of India,' vol. ix. 1883. From page (115) of the latter volume the following latitudes and longitudes have been selected:—

Stations	Latitude	Longitude
Longitude station [G. T. S. of India]	12° 46′ 27″·00	44° 58′ 57″·45
Latitude station [G. T. S. of India]	12 46 27·00	44 58 57·65
Lord Lindsay's station	12 47 14·70	44 59 10·61

Intersected Points	Latitude	Longitude
Harbour Light-ship	12° 47′ 20″·5	44° 58′ 17″·6
Renny's flagstaff	12 47 3·5	44 58 41·7
Saluting Pier flagstaff	12 47 20·9	44 58 57·5
Residency flagstaff	12 46 45·1	44 58 28·2
Sham Sham flagstaff	12 46 30·3	45 0 40·9
Light-house (Marshag)	12 45 43·0	45 3 18·8

From page (110), *loc. cit.*, we learn that in May 1877, 'Lord Lindsay's longitude station . . . was marked by an old cannon embedded in the ground nearly opposite the middle building of the "Prince of Wales' Crescent," but the Aden Municipality were then preparing a stone for the purpose of marking the site. The outer wall of the room in which Captain Heaviside took his Pendulum observations in 1873 is 86 feet distant from [this station], measured in a direction 27° west of south from that point.'

The final result for the difference of the meridians of Lord Lindsay's stations at Suez and Aden (p. 227) is:—

	h.	m.	s.
Aden east of Suez	0	49	43·75

Or—

	h.	m.	s.
Aden (Lord Lindsay's station) east of Greenwich	2	59	56·480

The latitude of this station, 12° 47′ 17″·3, has already been stated at p. 460, on the authority of Professor J. A. C. Oudemans. The high ground between Professor Oudemans' station and that of the G. T. Survey accounts for the discordance between the derived latitudes of the longitude station.

Bombay.

The longitude is that of the transit instrument of the Colába Observatory, Bombay.

At p. 195 we have :—

	h.	m.	s.
Bombay (transit instrument of the Colába Observatory) east of Lord Lindsay's station at Aden	1	51	18·94

Or—

	h.	m.	s.
Bombay east of Greenwich	4	51	15·420

Seychelles. Mahé Island.

The actual station is near the sea end of Hodoul Jetty, 69 feet west and 5 feet south of the centre of the Water Police Station; also 1,151 feet east and 761 feet south of the English Church; or 1,302 feet east and 1,735 feet south of the Roman Catholic Church as laid down on the chart of *Barachois or PORT VICTORIA, by the officers of H.M.S. 'Fawn,' under . . . Commander W. J. L. Wharton, R.N.*, 1877. The latitude from the same source is 4° 37′ 15″ south.

The result at p. 179 makes :—

	h.	m.	s.
Seychelles (Hodoul Jetty, defined as above) east of Aden (Lord Lindsay's station)	0	41	52·43

Or—

	h.	m.	s.
Hodoul Jetty east of Greenwich	3	41	48·910[1]

Réunion.

The point of reference is the flagstaff at St. Denis (see p. 173), where it is found that St. Denis is east of Aden $0^h\ 41^m\ 50^s{\cdot}17$. This quantity has still to be corrected by $-0^s{\cdot}26$ for the personal equation between Mr. Soeters and Mr. Gill as given on p. 197. We have therefore as a final result :—

	h.	m.	s.
St. Denis east of Aden (Lord Lindsay's station) . . .	0	41	49·91

Or—

	h.	m.	s.
St. Denis east of Greenwich	3	41	46·390

[1] The chart mentioned above makes the longitude $3^h\ 41^m\ 49^s{\cdot}53$.

Mauritius.

On the island of Mauritius the fundamental point, as far as we are concerned, is Lord Lindsay's observatory at Belmont. There are, however, five other points on the island that come under consideration, viz. :—

1. The summit of Pouce Mountain.
2. The Belmont distant Meridian Mark on Blanche Mountain.
3. The Martello Tower at Fort George.
4. The Royal Alfred Observatory at Pamplemousses.
5. The German Transit of Venus Station at Solitude.

We shall first state the latitude and longitude of Belmont, and then give the various results for the other stations and their connections *inter se.*

Belmont.

The normal point is preserved by the round granite pillar on which the transit instrument stood. The final latitude for this point is (p. 472) :—

$$-20^\circ\ 2'\ 57''{\cdot}03 \pm 0''{\cdot}10.$$

From p. 171 we take the longitude of Belmont east of Aden as found by chronometers on the return journey, $0^h\ 50^m\ 43^s{\cdot}32 \pm 0^s{\cdot}40$, or Belmont east of Greenwich $3^h\ 50^m\ 39^s{\cdot}80$; while at p. 489 the result arrived at by the aid of the moon is $3^h\ 50^m\ 41^s{\cdot}27$. Neglecting altogether the uncertain result deduced from the chronometers on the outward journey, we may take the mean of the above quantities :—

	h.	m.	s.
Belmont Transit Pier east of Greenwich . . .	3	50	40·53

as the longitude of the station.

Pouce Mountain.

The summit of this mountain is the zero of rectangular co-ordinates in the Colonial Survey of the island. 'The present signal is a concrete column about 5 feet high, with metal cap,' centred over a brass pin secured in the solid rock. To the Honourable M. Connal, Surveyor-General of the colony, we are indebted for the following rectangular co-ordinates in British feet of the various points already enumerated. No base has been measured in recent times, but, from many independent controls, it is certain that no error larger than a very few feet can affect these dimensions :—

Name of station	From Pouce Signal	
	Along meridian	Along prime vertical
	feet	feet
Lord Lindsay's Observatory, Belmont, Transit Column . . .	N. 53,662	E. 48,589
Belmont Meridian Mark on Blanche Mountain	S. 25,748	E. 48,571
Martello Tower, Fort George	N. 18,484	W. 12,686
Royal Alfred Observatory, Pamplemousses, transit instrument .	N. 36,634	E. 10,520
German Transit Observatory, Solitude. Site of transit instrument .	S. 81,190	E. 46,217

We assume that these are practically Soldner's[1] co-ordinates, in which case, *e.g.*, Belmont Observatory would be reached by first proceeding northwards from the Pouce along the meridian for 53,662 feet, and then following the prime vertical of the point so reached to the east for 48,589 feet. If the co-ordinates were Gauss's the meridional quantities would be the same, while those east and west would be nominally larger, but in none of the quantities here concerned would the difference be so much as 1 inch.

Taking, then, these co-ordinates, and adopting Bessel's dimensions of the earth, the geographical differences of latitude and longitude become :—

Name of station	Difference from Pouce	
	In latitude	In longitude
Belmont	N. 0° 8′ 52″·126	E. 0° 8′ 29″·690
Belmont Meridian Mark	S. 0 4 15·017	E. 0 8 30·211
Fort George	N. 0 3 3·235	W. 0 2 13·156
Pamplemousses Observatory	N. 0 6 3·143	E. 0 1 50·354
Solitude	S. 0 13 24·589	E. 0 8 5·961

Belmont Meridian Mark.

This was a large signal erected on the crest of the Blanche Mountain more than 13 nautical miles south of Belmont. It was erected chiefly with a view to checking the orientation of the maps of the island. From micrometrical comparisons with the middle wire of the transit instrument, details of which will be given in the next volume, it was found that this signal was 1′ 33″·16 to the east of due south. This corresponds to 35·87 feet, or 0″·377 in longitude. Deducting this from the longitude of the Meridian Mark as given by the co-ordinates from the Pouce, there results :—

Belmont Meridian in latitude of Meridian Mark to east of Pouce (by survey)	8′ 29″·834
While Belmont is east of Pouce (by survey)	8 29·690
Difference	0 0·144

The difference corresponds to 13·73 feet.

Fort George.

The Martello Tower at this fort was the site of the first tentative observations on arrival at Mauritius as detailed on p. 63. The latitude and longitude as transferred from Belmont by means of the co-ordinates are :—

Latitude −20° 8′ 45″·92 ; longitude E. 3 h. 49 m. 57·67 s.

while the quantities found by Navigating Lieutenant J. E. Coghlan, R.N., in 1877 are :—

−20° 8′ 37″ and E. 3 h. 49 m. 58·13 s.

The difference in latitude, 8″·92, is considerable, but only when taken in connection with the discordances at the following stations does it attain a special significance.

[1] See vol. ii. chap. vi. of *Handbuch der Vermessungskunde* : W. Jordan. 2 vols. 8vo. Stuttgart, 1877–8.

Royal Alfred Observatory, Pamplemousses.

'The station in this case is the point over which the transit instrument of the present observatory stands.' The ground floor is 178 feet above mean sea level.

At p. 460 the latitude was found to be

$$-20^\circ\ 5'\ 37''{\cdot}87 \pm 0''{\cdot}21.$$

From the interchange of signals by telegraph the final result at p. 148 is :—

	h.	m.	s.	s.
Belmont east of Pamplemousses	0	0	28·80	± 0·10

Or—

	h.	m.	s.
Pamplemousses east of Greenwich	3	50	11·73

The above telegraphic difference from the meridian of Belmont is confirmed by the difference by chronometers, which is $29^s{\cdot}00$, and also by the value $28^s{\cdot}68$ found by the bursting of rockets (see p. 139).

The difference of longitude derived from the survey is, however, only $6'\ 39''{\cdot}336$, or no less than $32''{\cdot}664$ less than found by telegraph. If the latitude of Pamplemousses be derived from that of Belmont by the aid of the survey we find $-20^\circ\ 5'\ 46''{\cdot}013$, or a difference of $8''{\cdot}143$ in the same sense as in the case of Fort George. These discrepancies point to an abnormally intense local attraction which we shall find still more clearly indicated on considering the next station.

Solitude.

Here again 'the station point' as defined by the survey 'is that where the transit instrument stood.' From observations by the German observers the latitude is

$$-20^\circ\ 25'\ 51''{\cdot}25,$$

subject to a final correction of possibly a few tenths of a second.

At pp. 120 and 121 we have the final results for the difference of meridians by chronometers and by telegraph, whence we may adopt :—

	h.	m.	s.
Solitude west of Belmont	0	0	0·885

Or—

	h.	m.	s.
Solitude east of Greenwich	3	50	39·64

If we now derive the latitude of Solitude from each of the northern stations by the aid of the survey, we find :—

Latitude of Solitude derived from				Difference, $\phi n - \phi s$
Fort George (Lieut. Coghlan)	-20°	25′	4″·824	+ 46″·426
Pamplemousses Observatory	−20	25	5·602	+ 45·648
Belmont Observatory	−20	25	13·745	+ 37·505

We have also the discordances in longitude :—

	By astronomical observations	By survey	Difference
Solitude west of Belmont	13″·275	23″·729	10″·454
Solitude east of Pamplemousses	418·725	375·607	43·118

Postponing a further consideration of these remarkable results for the moment, we give the summary for the last station of the series.

Rodriguez, Point Venus.

From the 'Account of Observations, &c.,' p. 353, we learn that 'about three-quarters of a mile N.E. of the little town of Port Mathurin, on the cliff, some 50 feet above and 200 yards distant from high-water mark, are the remains of an old fort, called on some charts *Fort Duncan*. This was the site selected, foundations on solid rock being everywhere accessible.'

On p. 111 we find from the transport of chronometers :—

	h.	m.	s.	s.
Rodriguez east of Pamplemousses	0	23	30·64	± 0·13

And consequently :—

	h.	m.	s.
Rodriguez east of Greenwich	4	13	42·37 [1]

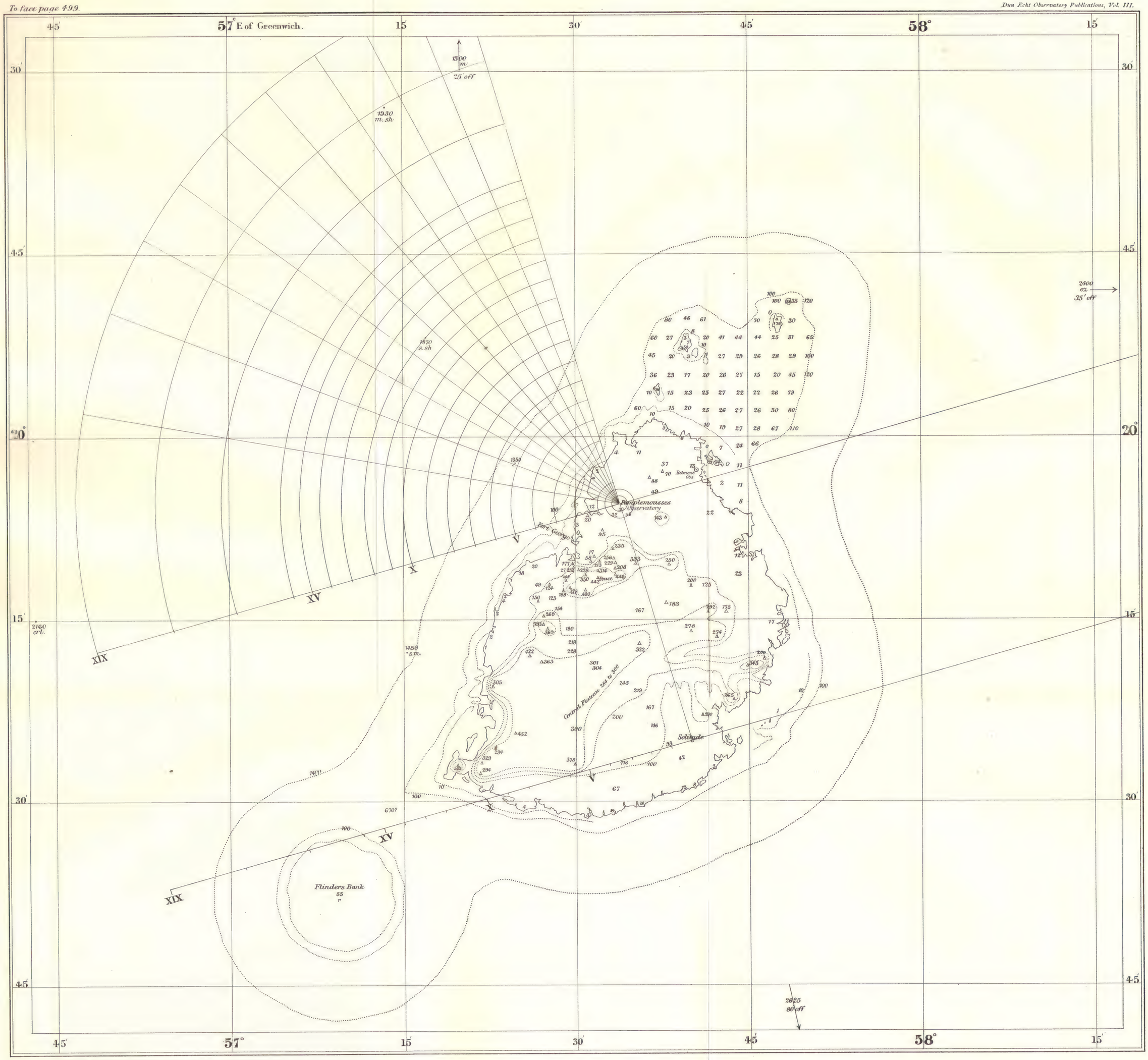
[1] For the same point the expedition under authority of the British Government found (see the *Account*, p. 365) :—

	h.	m.	s.
By the meridional transits of the moon	4	13	42·11
By the zenith distances [of the moon]			43·05
By the occultations of stars			42·52
Adopted mean	4	13	42·5 ± 1s·0

OUTLINE MAP OF MAURITIUS TO ILLUSTRATE CHAPTER XXIV.

THE HEIGHTS AND DEPTHS ARE EXPRESSED IN FATHOMS.

To face page 499.



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CHAPTER XXIV.

ON THE DEVIATIONS OF THE PLUMB-LINE EVINCED IN THE ISLAND OF MAURITIUS.

The great discrepancies between the astronomical co-ordinates and those derived from the survey of Mauritius call for the closest attention. One of the most startling of these is the difference of 32″·664, by which the astronomical longitude of Belmont, determined from Pamplemousses, exceeds that derived from a most reliable survey which has been tested again and again in its smallest details. The astronomical value is based, not only on signals by telegraph, but also on the transport of chronometers and the eminently simple observation of rocket signals. This latter method altogether precludes the possibility of an oversight of two whole seconds of time, which might otherwise be supposed to have crept into some part of the other operations. If we now turn to the latitudes, we find the really enormous discordances of 46″·426, 45″·648 and 37″·505, by which the latitude of the German observatory in the south of the island is astronomically too far removed from the respective parallels of Fort George, Pamplemousses and Belmont. The differences, again, of these figures show that the two first stations do not accord with the third within 8″. A glance at the configuration of the island (see outline map), at once suggests local attraction as the cause of these divergencies; but it soon becomes evident that no admissible mass can be ascribed to the mountains capable of producing such considerable effects; and it is only when we look to the profound depths of the surrounding ocean that the exceptionally high degree of isolation of Mauritius becomes fully apparent.

A depth of 1,450 fathoms has been found only four miles from the west coast, as shown in the map, while at a distance of ten or twenty miles the general floor of the Indian Ocean is only reached some 2,500 fathoms beneath the surface. The loftiest peaks of the island, rising about 2,700 feet above sea-level, are thus elevated nearly 18,000 feet above the bed of the ocean. Hence the astronomers at various points on the island may be considered as stationed high up the slopes of a huge mountain, the effect of whose attraction must be appreciably felt in their observations. This attraction is doubtless in part, but only in part, counterbalanced by the surrounding water. In endeavouring to estimate this effect, it is necessary to examine the materials afforded by the published chart of the island. If the outlying islets to the north-east are considered, in their true aspect, as the summits of a submerged extension of the island for some fifteen miles in that direction, the line of 100 fathoms is found to lie close in shore, being, in fact, sometimes less than half a mile, and very rarely so much as two miles, from the strand. Unfortunately the complete survey of the bottom terminates with the hundred-fathom line; *that* is laid down with all desirable precision in the new chart already mentioned; but outside of it there are only seven really available soundings, all of which are shown or indicated

on the accompanying map. One of these marks the position of Flinders Bank, as laid down on the chart of the Indian Ocean. Fortunately there are sufficient soundings in the latter chart to show that Mauritius is most probably separated from Réunion and Rodriguez by the full depth of the ocean, although there is room for thinking that there is a certain degree of connection, although at a profound depth, with the Nazareth Bank at a distance of 250 miles to the north-east, as indicated by the sounding of 1,300 fathoms shown on the map. The chart gives the elevations of the numerous peaks in the island, and, which is of far more importance in this case, the heights of the railway stations, the highest of which is 1,806 feet above the sea. There are thus sufficient materials for making a rough numerical estimate of the local attraction at any of the astronomical stations.

As an experiment we shall take the total deviation between Pamplemousses and Solitude, which amounts to no less than $55''{\cdot}595$ on the geodetic line. The complete theory of these investigations is to be found in the 'Ordnance Survey of Great Britain and Ireland: Account of the Principal Triangulation,' by Lieutenant-Colonel Sir H. James, London, 1858, p. 575 *et seq.*[1] It is here only necessary to present the chief points of the method. At any place the deviation of the plummet due to A, the attraction of a given mass, is

$$\psi=\frac{3}{4}\frac{206265}{\pi\sqrt{ab}}\cdot\frac{A}{\delta}=12''{\cdot}447\frac{A}{\delta},$$

where δ is the mean density of the earth, $\sqrt{ab}=3956$ miles, or the mean semi-diameter of the earth. If another unit is taken in place of the statute mile, the constant must be suitably modified—*e.g.* by dividing by 880 if the fathom is used.

The formula for finding A can, as a rule, only afford an approximate value, the most generally available method being to consider a number of concentric circles described about the point of observation on the horizontal plane as defining the bases of a number of concentric cylinders, the cylinders thus formed being then divided into segments by radial vertical planes. The materials in each segment are then assumed to be levelled to a uniform height capable of estimation. If, now, α_1 and α' are the azimuths, referred to an adopted meridian, of the limiting vertical planes of one of these segments, r_1 and r' the radii of the bounding cylindrical surfaces, and $z=h$ the mean height of the segment, then the element of bulk $=r\,d\alpha\,dr\,dz$, and if ρ is its mean density, the attraction on the origin is

$$=\rho\frac{r\,d\alpha\,dr\,dz}{r^2+z^2},$$

and the corresponding attraction of the whole body in the direction of the meridian and in the plane of the horizon will be

$$=\rho\int_{\alpha_1}^{\alpha'}\int_{r_1}^{r'}\int_{0_1}^{h}\frac{r^2\,d\alpha\,dr\,dz\cos\alpha}{(r^2+z^2)^{\frac{3}{2}}}.$$

The integration gives the attraction

$$(1)\qquad A=\rho\,(\sin\alpha'-\sin\alpha_1)\log.\,\text{nat.}\,\frac{r'+\sqrt{r'^2+h^2}}{r_1+\sqrt{r_1^2+h^2}}.$$

[1] For a concise account illustrated by a numerical example, see *Die Zweite Deutsche Nordpolarfahrt in den Jahren* 1869 *und* 1870, Band II. pp. 845 *et seq.*

Developing the logarithm, and taking $(r'-r_1)$ sufficiently small compared with $r'+r_1$, we have

$$A=\rho\,(r'-r_1)\,(\sin\alpha'-\sin\alpha_1)\,\frac{h}{\sqrt{r^2+h^2}}, \tag{2}$$

where $r=\frac{1}{2}\,(r'+r_1)$, and where, as a rule, we can write without appreciable error

$$A=\rho\,(r'-r_1)\,(\sin\alpha'-\sin\alpha_1)\,\frac{h}{r}. \tag{2a}$$

This formula indicates a most convenient rule for drawing the radii and concentric circles—viz. by making the difference of the successive radii and the difference of the sines of the azimuths each constant. Calling these differences (r) and (s), and noting that $\frac{1}{2}\,(r_{n+1}+r_n)=n\,(r)+\frac{1}{2}\,(r)$, the attraction of the whole of the ground from the 1st to the $(n+1)$th circle is

$$A=\rho\,(s)\sum_{n=1}^{n=n}\frac{H_n-H_n'}{n+\frac{1}{2}},$$

where H_n is the sum, in miles, of the heights to the north, and H_n' that of those to the south between the indicated rings. The deviation of the plummet therefore becomes

$$\psi=24''\cdot894\,(s)\sum_{n=1}^{n=n}\frac{H_n-H_n'}{2n+1}\cdot\frac{\rho}{\delta}.$$

Another simple method is arrived at by neglecting h in comparison with r in (1). We then have

$$A=\rho\,(s)\,\text{log. nat.}\,\frac{r'}{r_1},$$

which shows that we may also draw the circles in geometrical progression, while the rule already deduced for the radii is retained. The deviation is then represented by

$$\psi=12''\cdot447\,(s)\,\frac{\rho}{\delta}\,\text{log. nat.}\,\frac{r'}{r_1}\,(H-H').$$

Expressing the heights in fathoms in place of miles, and using Briggs's in place of the natural logarithms in the second formula, and putting further $s=0\cdot1$, $\rho=2\cdot75$ and $\delta=5\cdot5$, or $\frac{\rho}{\delta}=\frac{1}{2}$, we have for the first method of drawing the circles

$$\psi_1=0''\cdot0014145\left\{\frac{H_1-H_1'}{3}+\frac{H_2-H_2'}{5}+\ldots+\frac{H_n-H_n'}{2n+1}\right\};$$

and for the second method by setting $\frac{r'}{r_1}=\frac{7}{6}$,

$$\psi_2=0''\cdot00010902\,(H-H').$$

Wherever the circles fall on the water, a deviation takes place from the water towards the land in such a way that $\frac{\rho}{\delta}=\frac{1}{5\cdot5}-\frac{1}{2}$, or the attraction becomes $-\frac{7}{11}$ that of the same volume of land. The corresponding formulæ for the segments filled with water are therefore

$$\psi_1'=-0''\cdot0009001\,2\left\{\frac{D_1-D_1'}{3}+\frac{D_2-D_2'}{5}+\ldots+\frac{D_n+D_n'}{2n+1}\right\},$$

and

$$\psi_2'=-0''\cdot000\,69377\,(D-D').$$

In applying these formulæ to the case of finding the effect of local attraction on the distance between Pamplemousses and Solitude, the fathom was adopted as the most convenient unit of height and depth. From the somewhat scanty data, contour lines of 100, 200, and 300 fathoms were laid down on the land. For the water the nautical survey furnished the complete line of 100 fathoms of depth and also portions of a ten-fathom line. From the very numerous soundings in the comparatively shoal water between the islets in the N.E. mean values were taken for every two square miles or thereabouts, while from the soundings of 1,450 and 1,350 fathoms off the west coast the distance of a 1,400-fathom line from the strand was assumed as constant all round the island. The three more distant soundings of 2,160, 1,870 and 1,930 fathoms towards the north-west caused 1,900 fathoms to be assumed as the maximum depth to the north and west. In making this assumption the 1,300-fathom measurement some forty miles to the north was neglected, as being beyond the range to which it was proposed to extend the calculation. To the east and south there are only two deep-sea measurements on record, viz. of 2,400 and 2,625 fathoms respectively. These warranted the adoption of not less than 2,200 fathoms as the maximum depth in those directions. Flinders Bank is stated to lie fifty-five fathoms beneath the surface. Around its outline, as laid down on the ocean chart, 100 and 1,400 fathom lines were traced on the assumption that its submerged sides everywhere slope to the same extent as the bottom off the western shore of the island. This declivity was assumed to be maintained in every case until the maximum depth of 1,900 to 2,200 fathoms was arrived at.

Round each station sixteen circles were described at intervals of two miles, and outside these three further circles, with radii increasing in the proportion of $\frac{7}{6}$, so that the outermost circle has a radius of 50·8 miles. This is sufficiently large to embrace the whole island and the surrounding water to a depth of 1,900 fathoms in the computation for each station. To allow for the attraction of the ground in the immediate neighbourhood of Pamplemousses, two smaller circles were drawn with radii of $\frac{2}{3}$ and $1\frac{1}{3}$ mile dividing the area inside the two-mile circle into three parts. The deviation from this source is marked ψ_3 in the sequel.

The line joining Pamplemousses and Solitude being taken as the zero of azimuth, ten diameters were drawn on each side of this medial line through each station, making the sines of the azimuth $\pm 0{\cdot}1$, $0{\cdot}2$ &c. To avoid crowding the map, the circles and radii are shown only for the north-west quadrant round Pamplemousses, but the lengths of the radii are laid down for both stations, and marked with Roman numerals. The two inner (unnumbered) circles round Pamplemousses are shown in full. Around Pamplemousses 840 areas were thus marked out, of which the mean heights or depths were taken from the map and entered in the subjoined table, where the small figures indicate spaces wholly or chiefly filled with water. The same thing was done for the 720 areas outside the two-mile circle at Solitude; while within that circle the heights were assumed to be the same as at Pamplemousses, except that north and south are interchanged. This plan was rendered necessary by our almost complete ignorance of the relative heights in the neighbourhood of Solitude. It is hardly necessary to repeat that the heights as well as the depths are in fathoms. The columns H and D show the sums of the heights and depths respectively, those to the southward being marked with an accent.

1. SOLITUDE OBSERVATORY.

a, Northwards.

Ring between circles	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	H	D
1 and 2	97	97	97	96	95	92	92	92	90	90	90	95	130	180	180	150	150	120	80	10	2,123	...
2 „ 3	100	100	100	130	167	120	92	92	95	90	90	95	130	120	80	90	80	80	200	13	2,051	13
3 „ 4	100	105	120	150	160	180	140	140	150	150	140	130	130	130	130	130	140	140	60	10	2,525	10
4 „ 5	140	180	210	220	260	230	220	220	210	190	170	150	140	110	100	70	80	200	180	6	3,280	6
5 „ 6	280	290	300	300	300	300	290	280	220	180	170	170	220	200	180	100	21	14	10	10	3,825	10
6 „ 7	270	300	300	290	250	200	150	130	160	100	150	150	110	160	170	170	20	15	3	40	3,095	43
7 „ 8	260	300	300	240	190	100	100	100	100	100	100	100	140	110	60	24	15	2	40	300	2,341	340
8 „ 9	220	280	350	220	230	100	180	200	300	220	220	220	90	25	24	23	10	8	200	750	2,912	958
9 „ 10	120	140	120	100	110	120	170	200	230	230	90	30	28	24	15	1	50	250	600	1,150	1,727	2,051
10 „ 11	0	10	0	4	5	25	20	5	30	35	35	35	25	22	10	40	120	650	1,050	1,550	251	3,420
11 „ 12	10	200	110	100	50	5	40	30	20	30	35	45	25	10	8	45	450	1,000	1,500	1,900	165	5,448
12 „ 13	150	700	700	500	350	300	300	100	5	15	40	60	40	2	11	300	800	1,350	1,900	2,200	155	9,668
13 „ 14	400	1,250	1,200	1,000	900	750	650	400	100	2	6	25	15	2	11	400	1,000	1,650	2,200	2,200	48	14,113
14 „ 15	900	1,700	1,600	1,500	1,350	1,200	1,000	750	400	100	2	6	2	8	35	400	1,000	1,900	2 200	2,200	10	18,243
15 „ 16	1,000	1,900	2,000	1,900	1,750	1,600	1,300	1,000	750	400	90	6	12	20	27	110	1,000	2,100	2,200	2,200	...	21,365
16 „ 17	1,100	1,900	1,900	1,900	1,900	1,900	1,900	1,750	1,400	1,000	600	60	20	25	20	90	1,100	2,200	2,200	2,200	...	25,165
17 „ 18	1,300	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,300	600	100	110	40	200	1,450	2,200	2,200	2,200	...	28,800
18 „ 19	1,800	1,950	1,950	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,800	1,400	1,200	950	1,150	2,000	2,200	2,200	2,200	...	36,000
Rad. in miles 1·667	These areas are assumed to be of the same heights as the corresponding ones *south* of Pamplemousses.																				715	...
Rad. in miles 1·000																					586	...
Rad. in miles 0·333																					580	...

b, Southwards.

Ring between circles	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	H'	D'
1 and 2	1	3	2	0	2	2	3	3	4	5	6	8	10	14	16	18	18	20	40	60	235	...
2 „ 3	2	40	40	80	90	100	120	120	120	110	100	90	60	30	0	4	10	20	40	60	134	1,102
3 „ 4	30	100	240	350	450	500	520	550	600	550	540	450	400	350	300	150	80	10	30	70	100	6,170
4 „ 5	100	400	600	800	900	1,000	1,000	1,000	1,000	1,000	950	900	850	700	640	500	350	150	5	60	60	12,845
5 „ 6	500	800	1,000	1,200	1,350	1,400	1,450	1,500	1,500	1,450	1,400	1,300	1,200	1,100	1,000	900	700	400	90	60	60	20,240
6 „ 7	850	1,250	1,400	1,550	1,700	1,800	1,900	1,900	1,900	1,900	1,750	1,650	1,600	1,500	1,450	1,250	1,000	700	300	10	10	27,350
7 „ 8	1,250	1,600	1,800	1,950	2,100	2,200	2,200	2,200	2,200	2,200	2,200	2,100	2,000	1,900	1,800	1,600	1 300	1,000	600	200	...	34,400
8 „ 9	1,550	2,000	2,200	2,200	2,200	...	...	...	...	...	...	2,200	2,200	2,200	2,200	1,900	1,600	1,300	1,000	400	...	38,350
9 „ 10	1,950	2,200	...	...	...	...	...	...	...	...	...	...	...	...	...	2,200	2,050	1,750	1,450	600	...	40,800
10 „ 11	2,200	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,200	2,100	1,700	800	...	42,000
11 „ 12	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,200	2,050	1,000	...	42,650
12 „ 13	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,200	1,000	...	42,800
13 „ 14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,200	900	...	42,700
14 „ 15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,100	600	...	42,300
15 „ 16	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,000	100	...	41,700
16 „ 17	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,000	100	...	41,700
17 „ 18	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,200	300	...	42,100
18 „ 19	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,200	1,600	...	43,400
Rad. in miles 1·667	These areas are assumed to be of the same heights as the corresponding ones *north* of Pamplemousses.																				280	...
Rad. in miles 1·000																					294	...
Rad. in miles 0·333																					497	...

2. Pamplemousses Observatory.

a, Northwards.

Ring between circles	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	H	D
1 and 2	2	2	0	2	2	5	8	8	8	8	8	8	8	8	10	15	20	30	50	55	257	0
2 „ 3	50	130	130	130	130	130	140	100	90	80	30	2	4	4	4	8	12	20	25	40	117	1,142
3 „ 4	450	480	520	560	600	550	500	470	380	300	150	80	20	10	10	2	6	12	10	14	44	5,080
4 „ 5	750	860	1,050	1,080	1,100	1,050	1,000	800	700	600	520	470	300	120	60	10	5	5	4	0	...	10,484
5 „ 6	900	1,300	1,350	1,350	1,350	1,350	1,300	1,250	1,100	940	900	800	500	300	90	10	15	18	16	7	...	14,846
6 „ 7	1,300	1,600	1,700	1,720	1,750	1,750	1,750	1,600	1,450	1,250	1,040	850	800	400	110	36	20	20	25	27	...	19,198
7 „ 8	1,630	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,760	1,550	1,340	1,000	760	380	90	40	6	20	25	27	...	21,928
8 „ 9	1,900	...	...	...	...	...	...	...	1,900	1,850	1,550	1,250	950	540	160	55	6	25	27	30	...	23,543
9 „ 10	...	...	...	...	...	...	...	...	...	1,900	1,900	1,700	1,260	900	500	120	60	40	30	80	...	25,590
10 „ 11	...	...	...	...	...	...	...	...	...	...	...	1,900	1,550	1,220	840	500	300	300	35	90	...	27,635
11 „ 12	...	...	...	...	...	...	...	...	...	...	...	...	1,860	1,500	1,150	900	740	380	40	500	...	29,870
12 „ 13	...	...	...	...	...	...	...	...	...	...	...	...	1,900	1,850	1,560	1,300	950	550	40	800	...	31,750
13 „ 14	...	...	...	...	...	...	...	...	...	...	...	...	...	1,900	1,900	1,650	1,400	940	400	1,300	...	34,190
14 „ 15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,900	1,700	1,340	900	1,500	...	35,840
15 „ 16	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,900	1,680	1,300	1,900	...	37,180
16 „ 17	1,950	1,950	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	...	38,100
17 „ 18	2,050	2,050	2,000	2,000	1,950	1,950	1,900	1,900	...	...	...	...	...	...	...	...	...	...	1,900	1,900	...	38,600
18 „ 19	2 150	2,100	2,050	2,000	1,950	1,950	1,950	1,950	...	...	...	...	...	...	...	...	...	...	2,200	2,200	...	39,500
Rad. in miles 1·667	5	2	2	3	3	2	2	3	6	10	14	16	18	20	22	24	27	32	33	36	280	...
Rad. in miles 1·000	12	2	3	4	5	5	5	6	6	10	14	18	19	20	22	24	27	28	31	33	294	...
Rad. in miles 0·333	20	20	21	21	22	22	23	23	24	24	25	26	26	27	27	28	28	29	30	31	497	...

b, Southwards.

Ring between circles	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	H′	D′
1 and 2	40	60	40	35	35	35	35	45	45	50	50	60	60	60	60	60	60	60	40	20	950	...
2 „ 3	30	40	40	30	32	35	50	80	90	120	200	200	200	200	200	150	20	20	10	0	1,747	...
3 „ 4	20	25	28	40	60	150	150	140	140	140	150	160	250	300	300	350	300	200	80	35	2,983	35
4 „ 5	15	22	24	25	40	70	100	100	100	100	100	100	100	100	100	160	200	200	120	10	1,776	10
5 „ 6	2	12	15	25	50	100	100	120	150	150	100	150	120	110	100	100	100	100	100	10	1,704	10
6 „ 7	90	5	12	23	50	120	190	220	200	200	210	290	280	250	200	160	150	240	70	50	2,865	145
7 „ 8	500	60	3	20	40	90	200	160	140	130	200	210	260	290	290	240	200	180	20	150	2,673	710
8 „ 9	850	220	10	6	16	35	40	110	130	130	110	160	200	260	300	300	320	350	20	800	2,487	1,880
9 „ 10	1,100	600	150	8	10	80	190	160	80	80	60	120	130	200	280	300	300	300	0	1,050	2,290	2,908
10 „ 11	1,500	1,050	360	70	5	2	50	140	90	120	90	120	100	130	160	300	300	250	55	1,300	1,850	4,342
11 „ 12	1,950	1,400	800	300	10	10	6	10	10	40	60	90	100	110	250	270	320	10	90	1,600	1,250	6,186
12 „ 13	2,200	1,700	1,150	600	200	40	10	10	2	4	40	60	100	100	300	300	290	0	200	1,800	1,194	7,912
13 „ 14	...	2,100	1,500	1,000	600	350	200	60	50	20	10	20	40	60	60	100	200	10	400	1,800	500	10,280
14 „ 15	...	2,200	1,900	1,400	1,000	800	500	360	360	220	200	85	20	2	8	10	40	50	400	1,800	110	13,445
15 „ 16	...	...	2,200	1,700	1,400	1,150	950	800	750	700	650	450	300	100	200	100	55	10	400	1,800	...	18,115
16 „ 17	...	...	...	2,200	2,150	1,950	1,750	1,600	1,500	1,500	1,400	1,300	1,100	1,000	950	950	700	600	650	1,800	...	29,700
17 „ 18	...	...	...	...	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200	...	2,000	800	100	100	1,800	...	37,800
18 „ 19	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,200	900	100	100	1,800	...	38,100
Rad. in miles 1·667	39	39	40	40	41	41	42	42	42	41	40	38	36	34	33	31	30	28	26	12	715	...
Rad. in miles 1·000	35	35	34	34	33	33	32	32	31	31	30	29	29	28	28	27	26	25	20	14	586	...
Rad. in miles 0·333	33	33	33	32	32	32	31	31	30	30	29	29	28	28	25	26	26	25	23	24	580	...

By the aid of the formulæ already given we obtain directly the values of the local attraction at each station.

SOLITUDE.

$\frac{H_n-H'_n}{2n+1}$	ψ_1	$\frac{D_n-D'_n}{2n+1}$	ψ_1'	$D-D'$	ψ_2'	$\frac{H_n-H'_n}{2n+1}$	ψ_3
629·3	+0″·8901	0·0	0″·0000	−16535	+1″·1471	See Pamplemousses	See Pamplemousses
383·4	+0·5423	− 217·8	+0·1960	−13300	+0·9227		
346·4	+0·4900	− 880·0	+0·7921	− 7400	+0·5134	...	...
357·8	+0·5061	−1426·6	+1·2841	...	...	...	...
342·3	+0·4842	−1839·1	+1·6554	...	...	...	...
237·3	+0·3357	−2100·5	+1·8907	...	...	...	...
156·1	+0·2208	−2270·7	+2·0439	...	...	...	...
171·3	+0·2423	−2039·4	+1·8357	...	...	...	...
90·9	+0·1286	−2042·1	+1·8381	...	...	...	...
12·0	+0·0170	−1837·1	+1·6535	...	...	...	...
7·2	+0·0102	−1617·5	+1·4559	...	...	...	...
6·2	+0·0088	−1325·3	+1·1929	...	...	...	...
1·8	+0·0025	−1058·8	+0·9530	...	...	...	...
0·3	+0·0004	− 829·6	+0·7467	...	...	...	...
0·0	+0·0000	− 656·0	+0·5905	...	...	...	...
$\Sigma\psi_1$ =	+3·8790	$\Sigma\psi_1'$ =	+18·1286	$\Sigma\psi_2'$ =	+2·5832	$\Sigma\psi_3$	+0·2096

Hence the total deviation of the plumb-line at Solitude towards Pamplemousses is 24″·80.

PAMPLEMOUSSES.

$\frac{H_n-H'_n}{2n+1}$	ψ_1	$\frac{D_n-D'_n}{2n+1}$	ψ_1'	$D-D'$	ψ_2'	$\frac{H_n-H'_n}{2n+1}$	ψ_3
−231·0	−0″·3267	0·0	0″·0000	+8400	−0″·5828	−27·7	−0″·0878
−326·0	−0·4611	+ 228·4	−0·2056	+ 800	−0·0555	−58·4	−0·0826
−419·9	−0·5939	+ 720·7	−0·6487	+1400	−0·0971	−62·1	−0·0392
−197·3	−0·2791	+1163·8	−1·0476	...	...	...	...
−154·9	−0·2191	+1348·7	−1·2140	...	...	...	...
−220·4	−0·3118	+1465·6	−1·3192	...	...	...	...
−178·2	−0·2521	+1414·5	−1·2732	...	...	...	...
−146·2	−0·2068	+1274·3	−1·1470	...	...	...	...
−120·5	−0·1704	+1193·8	−1·0746	...	...	...	...
− 88·1	−0·1246	+1109·2	−0·9984	...	...	...	...
− 54·3	−0·0768	+1029·7	−0·9269	...	...	...	...
− 47·8	−0·0676	+ 953·6	−0·8584	...	...	...	...
− 18·5	−0·0262	+ 885·6	−0·7971	...	...	...	...
− 3·8	−0·0054	+ 772·2	−0·6951	...	...	...	...
0·0	0·0000	+ 615·0	−0·5536	...	...	...	...
$\Sigma\psi_1$ =	−3·1216	$\Sigma\psi_1'$ =	−12·7594	$\Sigma\psi_2'$ =	−0·7354	$\Sigma\psi_3$ =	−0·2096

The total deviation at Pamplemousses in the direction of Solitude is therefore 16″·83, or the total convergence of the plumb-line at the two stations, due to local attraction, is 41″·63, as derived from the foregoing discussion of the available heights and depths of the surrounding area. The quota afforded by each ring has been given separately to show where the chief

disturbance takes its rise. A cursory examination of the numbers in column ψ_1' might lead to the supposition that an extension of the circles would still show a considerable increase of local attraction. Such, however, is not the case; for an extra ring round each station more than eight miles in breadth only adds $0''{\cdot}2$ to the total convergence.

The result thus attained is still nearly $14''$ less than the difference between the survey and the astronomical latitudes and longitudes. The discrepancy, however, may be partly owing to an under-estimation of the general bulk of the island, as well as to the partial neglect of the attraction of smaller elevated masses close to the stations. In particular, from a general recollection of the *terrain*, it seems possible that when materials shall become available for the construction of exact contours in the neighbourhood of Solitude, it will be found that the attraction of the ground immediately to the north of that station will turn out to be much greater than that given above. If a reference to the existing, but unpublished, surveys shows any considerable extension of the central plateau of the island, especially between the two stations, such extension would very materially augment the attraction to be ascribed to the land. If, at the same time, it should be found that the water to the north, and still more to the south, of the island is deeper than estimated in the foregoing tables, or if the deep water comes much closer in shore, the local deviation will be still greater. In this way it is possible that an examination of the land and the water may fully account for the whole of the $55''{\cdot}6$ of local attraction required to reconcile the observations made at the two stations. On the other hand, it seems hardly possible, in the face of existing measurements, so to distribute the masses as to bring the computed local attraction below the very considerable amount of $30''$; so that at all events we have here to deal with this phenomenon in one of its most strongly pronounced aspects, and quite sufficiently pronounced to account for the greater part of the observed discrepancies.

On the basis of the meagre detail at present available, it would be a mere waste of time to endeavour to effect a numerical reconciliation of the latitudes and longitudes of the various stations on the island.

Two things, however, suggest themselves in the most forcible manner: first, that the determination of a few latitudes in Mauritius, combined with a fair number of soundings extending to some thirty miles from the island, together with data for the land that can doubtless be readily supplied by existing surveys of the colony, would afford a very acceptable contribution to our knowledge of the density of the earth. The specific gravity of the various strata of which the island is composed can be found from average specimens collected for the purpose; but it would be well to supplement these by samples from any borings that may have been made in search of water. The second consideration is the obvious danger of the transference of latitudes and longitudes to neighbouring points by the aid of charts. This is particularly the case near the sea, where the absence of high ground may convey a feeling of fancied security against local disturbance of the plumb-line, which would be altogether dispelled by an examination of the surrounding water-covered depths.

APPENDIX.

I.

MEAN RIGHT ASCENSIONS OF THE LONGITUDE STARS.

IMMEDIATELY after the return of the expedition in 1875, Mr. Gill proceeded to form a catalogue of the right ascensions of the stars used in the longitude operations. One exception, however, was made in the case of the stars used in connecting Mauritius with Rodriguez, both for the time determinations and the personal equation experiments on December 25–27, 1874, the reduction of the Rodriguez observations being made, in the first instance, by Lieutenant Neate. A special list of these stars will be given further on.

The stars used in the experiments at Dun Echt in 1876 form a second exception: of these also a separate list will be given.

To reduce the right ascensions to a homogeneous system Mr. Gill formed or adopted the following table of corrections to be applied to various catalogues :—

TABLE OF CORRECTIONS TO REDUCE VARIOUS CATALOGUES TO NEWCOMB'S STANDARD CATALOGUE OF RIGHT ASCENSIONS.

Right Ascension	Greenwich 7-year cat. 1860	Greenwich 2nd 7-year cat. 1864	Mittlere Oerter 1875	Washington catalogue 1860	Cape catalogue 1860	Melbourne catalogue 1870
h.	s.	s.	s.	s.	s.	s.
0	+0·08	+0·06	+0·03	+0·04	+0·07	+0·06
1	+0·06	+0·05	+0·03	+0·03	+0·05	+0·06
2	+0·04	+0·04	+0·03	+0·02	+0·03	+0·06
3	+0·04	+0·03	+0·02	+0·01	+0·04	+0·04
4	+0·02	+0·02	0·00	+0·01	+0·02	+0·02
5	+0·03	+0·02	−0·01	0·00	+0·04	0·00
6	+0·05	+0·03	0·00	0·00	+0·07	−0·01
7	+0·03	+0·03	+0·01	−0·01	+0·08	−0·01
8	+0·03	+0·03	+0·02	−0·01	+0·06	−0·01
9	+0·03	+0·03	+0·02	−0·01	+0·05	−0·01
10	+0·02	+0·03	+0·02	0·00	+0·04	0·00
11	+0·02	+0·02	+0·02	0·00	+0·02	+0·01
12	+0·05	+0·02	+0·02	0·00	+0·01	+0·02
13	+0·06	+0·03	+0·03	+0·01	+0·04	+0·03
14	+0·06	+0·04	+0·03	+0·02	+0·06	+0·04
15	+0·03	+0·04	+0·03	+0·03	+0·06	+0·06
16	+0·05	+0·03	+0·03	+0·04	+0·04	+0·07
17	+0·05	+0·04	+0·03	+0·04	+0·06	+0·08
18	+0·05	+0·05	+0·02	+0·05	+0·05	+0·08
19	+0·05	+0·05	+0·02	+0·05	+0·05	+0·08
20	+0·06	+0·06	+0·02	+0·05	+0·04	+0·07
21	+0·06	+0·06	+0·02	+0·05	+0·05	+0·06
22	+0·06	+0·07	+0·03	+0·05	+0·05	+0·05
23	+0·07	+0·07	+0·03	+0·04	+0·07	+0·04

The six catalogues included in this table are :—

1. Greenwich seven-year catalogue of 2,022 stars for 1860.
2. Greenwich new seven-year catalogue of 2,760 stars for 1864.
3. Mittlere Oerter für 1875·0 von 539 Sternen, &c.
4. Washington catalogue of stars observed . . . 1845 to 1871, 'Washington Observations,' 1871, Appendix III.
5. The Cape catalogue of 1,159 stars . . . reduced to 1860.
6. First Melbourne general catalogue of 1,227 stars for . . . 1870.

The corrections are such as to make the resulting list almost exactly in accordance with the 'Right Ascensions of the Equatorial Fundamental Stars,' deduced by Professor Newcomb in the third Appendix to the Washington Observations for 1870; in fact the fourth column is practically derived from a formula of Professor Newcomb's in a supplementary note to the Washington catalogue. Exceptions are the pole stars, which in the case of the northern stars were usually taken from the 'Mittlere Oerter,' while the places of the southern polar stars are derived, without alteration, from two papers fully referred to in the notes.

Whenever the known proper motion was appreciable, it has been taken into account in the apparent place, the Greenwich quantities having been preferably used. No special care was bestowed upon the declinations, except for the pole stars, for which they were usually taken from the same sources as the right ascensions.

A. Mean Right Ascensions of the Stars used in all the Longitude Operations excepting the Chronometric Connection with Rodriguez.

Star's name	Right Ascension, 1875·0			Annual variation in R.A.	Declination, 1875·0			Annual variation in declination	Number in 2nd 7-year cat. 1864	Number in Auwers' cat.	Other authorities, &c.
	h.	m.	s.	s.	°	′	″	″			
α Andromedæ	0	1	55·77	+3·088	+28	24	1·0	+19·91	3	1	
γ Pegasi	0	6	48·05	+3·083	+14	29	18·2	20·03	6	3	
β Hydri	0	19	9·17	+3·275	−77	57	33·2	20·25	...	...	Melb. and Cape Obs.
α Cassiopeiæ	0	33	25·48	+3·364	+55	51	4·5	19·79	70	10	
β Ceti	0	37	18·80	+3·012	−18	40	23·5	19·81	80	...	
γ Cassiopeiæ	0	49	10·68	+3·571	+60	2	20·7	19·57	...	13	
Cephei 43 H.	0	52	1·14	+7·037	+85	35	7·4	19·53	...	344	
β Andromedæ	1	2	44·32	+3·342	+34	57	26·4	19·21	145	16	
α Ursæ min.	1	12	59·00	...	+88	38	33·8	...	171	19	Greenwich clock list
θ Ceti	1	17	46·57	+2·998	−8	49	44·3	18·70	192	21	
α Eridani	1	33	3·39	+2·234	−57	52	19·4	18·41	...	...	Melbourne Obs.
β Arietis	1	47	44·24	+3·301	+20	11	45·9	17·78	248	30	
γ Andromedæ	1	56	13·92	+3·651	+41	43	43·4	17·48	264	32	
α Arietis	2	0	7·80	+3·368	+22	52	13·2	17·22	277	33	
β Trianguli	2	2	6·62	+3·548	+34	23	41·4	17·24	279	34	

MEAN RIGHT ASCENSIONS OF THE STARS USED IN ALL THE LONGITUDE OPERATIONS EXCEPTING THE CHRONOMETRIC CONNECTION WITH RODRIGUEZ (*continued*).

Star's name	Right Ascension, 1875·0			Annual variation in R.A.	Declination, 1875·0			Annual variation in declination	Number in 2nd 7-year cat. 1864	Number in Auwers' cat.	Other authorities, &c.
	h.	m.	s.	s.	°	′	″	″			
67 Ceti	2	10	44·97	+2·988	− 6	59	57·7	+16·76	307	353	
δ Ceti	2	33	4·64	+3·071	− 0	12	43·2	15·73	349	39	
Lacaille 1029	2	39	34·08	...	−86	16	9·1	...	...	...	Cat. of 78 stars, &c.*
41 Arietis	2	42	37·73	+3·514	+26	44	37·4	15·09	365	44	
α Ceti	2	55	44·78	+3·129	+ 3	35	51·9	14·33	387	47	
β Persei	3	0	2·45	+3·877	+40	28	20·4	14·18	391	50	
δ Arietis	3	4	28·97	+3·420	+19	15	8·7	13·91	401	359	
α Persei	3	15	24·40	+4·251	+49	24	50·7	13·13	419	52	
ξ Tauri	3	20	23·62	+3·236	+ 9	17	42·3	12·80	426	54	
f Tauri	3	23	58·44	+3·305	+12	30	24·1	12·60	436	55	
ε Eridani	3	27	2·49	+2·823	− 9	52	58·5	12·39	439	56	
10 Tauri	3	30	29·73	+3·057	+ 0	0	12·6	11·65	448	...	
Camelop. 5 H.	3	37	11·72	+6·214	+70	56	38·1	11·65	...	364	
17 Tauri	3	37	27·32	+3·550	+23	43	6·1	11·64	464	60	
η Tauri	3	40	3·36	+3·553	+23	43	0·3	11·45	474	61	
31 Tauri	3	45	20·39	+3·192	+ 6	9	27·5	11·14	483	...	
ζ Persei	3	46	16·70	+3·757	+31	30	37·0	11·02	486	63	
Lacaille 1273	3	49	7·70	+2·472	−28	2	29·5	10·49	495	...	
γ Hydri	3	49	11·87	−1·016	−74	37	17·9	10·98	...	..	Cape and Melb. cats.
33 Tauri	3	49	39·45	+3·550	+22	48	39·2	10·80	...	...	
γ^1 Eridani	3	52	11·87	+2·794	−13	51	56·7	10·49	500	...	
Groombridge 750	3	57	58·42	+16·847	+85	13	20·0	10·22	507	68	Auwers
o^1 Eridani	4	5	45·87	+2·926	− 7	9	55·1	9·67	522	366	
Lacaille 1592	4	5	56·73	...	−85	37	35·9	...	...	...	Cat. of 78 stars, &c.
α Horologii	4	9	51·60	+1·987	−42	36	12·4	9·09	...	...	Cape and Melb. cats.
γ Tauri	4	12	40·86	+3·407	+15	19	26·3	9·04	537	70	
χ^1 Tauri	4	14	58·64	+3·642	+25	19	55·9	8·83	541	...	
δ Tauri	4	15	43·62	+3·451	+17	14	50·6	8·78	544	71	
ε Tauri	4	21	19·13	+3·496	+18	54	4·5	8·35	559	72	
α Tauri	4	28	44·96	+3·436	+16	15	21·8	7·61	573	73	
Groombridge 848	4	32	2·93	+7·949	+75	42	32·7	7·38	582	369	
τ Tauri	4	34	44·62	+3·593	+22	42	53·8	7·26	589	370	
μ Eridani	4	39	15·24	+3·000	− 3	29	8·4	6·90	597	75	
π^4 Orionis	4	44	32·96	+3·192	+ 5	23	22·5	6·47	...	77	
π^5 Orionis	4	47	44·44	+3·121	+ 2	14	1·0	6·22	...	78	
ι Aurigæ	4	48	51·28	+3·898	+32	57	57·1	6·11	619	79	
Lacaille 1752	4	58	47·74	−1·784	−75	7	42·3	5·32	...	...	Cape Observations

* British Expedition for Observation of the Transit of Venus, 1874. Catalogue of 78 stars near the South Pole observed at the Royal Observatory, Cape of Good Hope, in the year 1871.

MEAN RIGHT ASCENSIONS OF THE STARS USED IN ALL THE LONGITUDE OPERATIONS EXCEPTING THE CHRONOMETRIC CONNECTION WITH RODRIGUEZ (*continued*).

Star's name	Right Ascension, 1875·0			Annual variation in R.A.	Declination, 1875·0			Annual variation in declination	Number in 2nd 7-year cat. 1864	Number in Auwers' cat.	Other authorities, &c.
	h.	m.	s.	s.	°	′	″	″			
ε Leporis	5	0	10·20	+2·536	−22	32	26·6	+5·10	643	...	
α Aurigæ	5	7	27·45	+4·424	+45	52	5·3	4·14	659	86	
β Orionis	5	8	31·87	+2·882	− 8	20	52·9	4·45	664	87	
B.A.C. 1648	5	13	8·57	+3·764	+27	49	42·3	4·01	...	...	= Piazzi V. 41
β Tauri	5	18	23·46	+3·789	+28	29	57·4	3·43	688	90	
δ Orionis	5	25	37·26	+3·067	− 0	23	37·7	2·96	708	93	
α Leporis	5	27	13·07	+2·646	−17	54	48·3	2·86	712	...	
B.A.C. 1746	5	28	4·90	+3·763	+27	34	42·5	2·73	...	...	= Piazzi V. 136
122 Tauri	5	29	48·55	+3·485	+16	57	39·2	2·64	723	...	
ε Orionis	5	29	52·28	+3·044	− 1	17	1·6	2·62	724	97	
β Doradûs	5	32	32·57	+0·514	−62	34	18·3	2·39	...	...	Cape and Melb. Obs.
α Columbæ	5	35	7·54	+2·179	−34	8	29·9	2·17	734	...	
ο Aurigæ	5	36	13·08	+4·642	+49	46	6·5	2·05	736	377	
γ Mensæ	5	36	50·54	...	−76	25	44·7	...	...	...	Cape Obs. to 1873
ι Mensæ	5	43	16·25	...	−78	53	3·1	...	...	...	Cape Observations
δ Leporis	5	45	56·74	+2·578	−20	53	28·6	0·56	761	...	
χ^2 Orionis	5	47	32·74	+3·556	+19	43	23·5	1·11	765	...	
α Orionis	5	48	24·29	+3·248	+ 7	22	53·5	1·01	766	102	
β Aurigæ	5	50	21·66	+4·402	+44	55	54·9	0·83	768	103	
1 Geminorum	5	56	31·33	+3·645	+23	16	4·2	0·20	780	...	
66 Orionis	5	58	22·16	+3·168	+ 4	9	49·9	+0·14	...	380	
ν Orionis	6	0	26·13	+3·427	+14	46	52·4	−0·06	784	382	
θ Leporis	6	0	30·01	+2·716	−14	55	32·9	0·03	...	...	
η Geminorum	6	7	19·94	+3·622	+22	32	26·9	0·64	796	105	
κ Columbæ	6	12	6·42	+2·134	−35	6	1·5	1·06	...	...	Cape Observations
Lacaille 2512	6	12	42·68	...	−85	55	32·8	...	...	...	Cat. of 78 stars, &c.
μ Geminorum	6	15	23·91	+3·633	+22	34	31·8	1·46	813	106	
α Argûs	6	21	10·61	+1·330	−52	37	41·3	1·85	...	...	
51 Aurigæ	6	29	59·72	+4·161	+39	29	55·5	2·71	846	389	
γ Geminorum	6	30	29·41	+3·467	+16	30	13·5	2·71	851	107	
15 Monocerotis	6	34	5·67	+3·307	+10	0	33·3	2·99	...	108	
ε Geminorum	6	36	14·45	+3·695	+25	15	9·6	3·16	860	109	
ξ Geminorum	6	38	16·39	+3·369	+13	1	41·7	3·54	865	110	
α Canis maj.	6	39	38·28	+2·646	−16	32	46·2	4·70	867	...	Newcomb
Cephei 51 H.	6	41	15·36	+30·265	+87	14	4·6	3·64	861	111	Auwers
θ Geminorum	6	44	32·93	+3·960	+34	6	34·6	3·90	...	112	

MEAN RIGHT ASCENSIONS OF THE STARS USED IN ALL THE LONGITUDE OPERATIONS EXCEPTING THE CHRONOMETRIC CONNECTION WITH RODRIGUEZ (*continued*).

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	h.	m.	s.	s.	°	′	″	″			
θ Canis maj.	6	48	22·96	+ 2·787	−11	53	1·0	−4·23	876	...	
ζ Mensæ	6	50	24·86	...	−80	40	44·9	...	...	...	Cape and Melb. Obs.
ϵ Canis maj.	6	53	42·84	+ 2·357	−28	48	12·2	4·68	884	...	
ζ Geminorum	6	56	41·68	+ 3·563	+20	45	5·6	4·91	886	113	
γ Canis maj.	6	58	6·27	+ 2·717	−15	27	0·2	5·04	890	..	
C Puppis	7	0	5·07	+ 1·896	−42	9	12·6	5·19	...	...	Cape Observations
63 Aurigæ	7	3	3·32	+ 4·138	+39	31	19·6	5·43	896	395	
δ Canis maj.	7	3	18·57	+ 2·439	−26	11	46·9	5·45	897	...	
51 Geminorum	7	6	11·60	+ 3·451	+16	22	8·1	5·74	902	...	
52 Geminorum	7	7	3·29	+ 3·678	+25	5	58·5	5·94	905	...	
64 Aurigæ	7	9	20·48	+ 4·184	+41	6	10·8	5·96	...	396	
λ Geminorum	7	10	54·55	+ 3·453	+16	45	49·9	6·15	911	114	
δ Geminorum	7	12	39·42	+ 3·591	+22	12	37·5	6·26	914	115	
π Argûs	7	12	43·71	+ 2·120	−36	52	27·2	6·26	...	...	Cape and Melb. Obs.
65 Aurigæ	7	13	41·39	+ 4·026	+36	59	36·4	6·34	915	...	
56 Geminorum	7	14	34·33	+ 3·552	+20	40	39·3	6·41	919	...	
ι Geminorum	7	17	57·72	+ 3·737	+28	2	40·1	6·78	...	117	
63 Geminorum	7	20	19·14	+ 3·568	+21	41	55·9	6·98	930	...	
β Canis min.	7	20	22·29	+ 3·258	+ 8	32	21·5	6·94	931	118	
68 Geminorum	7	26	28·40	+ 3·427	+16	5	37·0	7·39	939	...	
a^2 Geminorum	7	26	37·32	+ 3·839	+32	9	37·6	7·48	941	...	
π^1 Puppis	7	29	1·70	+ 2·542	−23	12	10·4	7·59	...	...	
o Geminorum	7	31	0·27	+ 3·932	+34	52	8·9	8·05	948	...	
f Geminorum	7	32	15·38	+ 3·471	+17	57	26·2	7·85	953	...	
a Canis min.	7	32	45·39	+ 3·144	+ 5	32	36·6	8·92	954	120	Newcomb
β Geminorum	7	37	39·89	+ 3·681	+28	19	33·8	8·35	964	122	
π Geminorum	7	39	26·68	+ 3·882	+33	43	14·0	8·45	968	400	
26 Lyncis	7	45	36·20	+ 4·389	+47	53	9·8	8·94	...	402	
9 Puppis	7	45	59·08	+ 2·778	−13	34	4·8	9·31	984	...	Cape and Greenwich Obs.
ω^2 Cancri	7	54	11·34	+ 3·636	+25	25	53·2	9·59	995	...	
6 Cancri	7	55	50·31	+ 3·697	+28	8	33·6	9·75	999	404	(=χ Geminorum)
15 Argûs	8	2	13·24	+ 2·554	−23	56	43·2	10·14	1010	...	
ψ^2 Cancri	8	2	55·38	+ 3·624	+25	53	5·2	10·60	1012	...	
Piazzi VII. 321	8	3	48·61	+ 3·788	+32	50	52·6	10·98	1014	...	
β Cancri	8	9	44·13	+ 3·259	+ 9	34	8·7	10·80	1025	123	

MEAN RIGHT ASCENSIONS OF THE STARS USED IN ALL THE LONGITUDE OPERATIONS EXCEPTING THE CHRONOMETRIC CONNECTION WITH RODRIGUEZ (*continued*).

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	h.	m.	s.	s.	°	′	″	″			
χ Cancri	8	12	28·23	+ 3·658	+27	37	14·5	−11·33	1030	...	
d^1 Cancri	8	16	12·29	+ 3·443	+18	43	54·4	11·24	1033	...	
ϕ^1 Cancri	8	18	51·45	+ 3·663	+28	18	12·8	11·51	1039	...	
η Cancri	8	25	28·71	+ 3·479	+20	51	50·8	11·93	1052	409	
39 Cancri	8	32	54·80	+ 3·455	+20	26	51·3	12·41	1066	...	
γ Cancri	8	36	3·00	+ 3·480	+21	54	59·8	12·61	1074	...	
δ Cancri	8	37	34·79	+ 3·420	+18	36	43·5	12·97	1078	126	
ι Cancri	8	39	7·78	+ 3·645	+29	12	54·7	12·92	1084	127	
ϵ Hydræ	8	40	9·34	+ 3·184	+ 6	52	33·7	12·92	1086	128	
Lacaille 3759	8	44	32·35	−11·802	−86	7	59·7	13·20	...	...	Cat. of 78 stars, &c.
ζ Hydræ	8	48	47·16	+ 3·178	+ 6	25	10·9	13·48	...	129	
ι Ursæ maj.	8	50	38·44	+ 4·138	+48	31	50·1	13·86	1109	130	
α Cancri	8	51	38·95	+ 3·283	+12	20	24·8	13·67	1113	131	
10 Ursæ maj.	8	52	31·10	+ 3·918	+42	16	33·5	13·98	1115	132	
τ Cancri	9	0	29·69	+ 3·625	+30	9	18·5	14·26	1127	...	
36 Lyncis	9	5	37·28	+ 3·953	+43	43	52·5	14·58	...	416	
α = 40 Lyncis	9	13	26·16	+ 3·676	+34	55	10·7	15·01	1146	136	
Draconis 1 H.	9	19	5·42	+ 9·097	+81	52	34·0	15·32	1153	137	
10 Leonis min.	9	26	33·63	+ 3·697	+36	57	4·5	15·74	...	419	
o Leonis	9	34	28·67	+ 3·208	+10	27	35·3	16·18	1190	141	
f Leonis	9	36	13·45	+ 3·537	+30	32	52·3	16·34	1194	...	
υ Ursæ maj.	9	42	5·08	+ 4·326	+59	37	29·6	16·73	1202	143	
μ Leonis	9	45	39·05	+ 3·423	+26	35	40·4	16·76	1211	144	
19 Leonis min.	9	50	1·29	+ 3·699	+41	38	58·9	16·94	...	422	
Piazzi IX. 230	9	55	50·65	+ 3·360	+22	33	3·3	17·19	1224	...	= B.A.C. 3423
η Leonis	10	0	30·94	+ 3·279	+17	22	16·5	17·38	...	145	
α Leonis	10	1	42·81	+ 3·202	+12	34	37·9	17·42	1230	146	
Piazzi IX. 254	10	3	26·42	+ 3·639	+41	16	30·2	17·49	1233	...	
λ Ursæ maj.	10	9	33·04	+ 3·643	+43	32	14·4	17·86	1245	147	
ζ Leonis	10	9	44·08	+ 3·348	+24	2	22·2	17·76	...	148	
μ Ursæ maj.	10	14	52·54	+ 3·600	+42	7	37·7	17·98	1255	149	
Camelop. 30 H.	10	15	38·98	+ 7·944	+83	11	34·5	17·98	...	425	
33 Leonis min.	10	24	45·39	+ 3·428	+33	1	13·3	18·34	1279	...	
ρ Leonis	10	26	13·63	+ 3·162	+ 9	56	56·4	18·41	1282	151	
42 Leonis min.	10	38	54·62	+ 3·353	+31	20	23·4	18·86	1310	431	
46 Leonis min.	10	46	18·96	+ 3·371	+34	53	18·5	19·27	1321	152	

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	h. m. s.	s.	° ′ ″	″			
Bradley 1508	10 49 53·43	+5·020	+78 26 20·3	−19·15	...	433	
ψ Ursæ maj.	11 2 37·72	+3·397	+45 10 33·4	19·51	1359	155	
ξ Ursæ maj. med.	11 11 30·56	+3·213	+32 13 55·8	20·19	...	158	
58 Ursæ maj.	11 23 44·92	+3·269	+43 51 33·0	19·72	...	437	
λ Draconis	11 23 57·64	+3·637	+70 1 14·1	19·84	1383	162	
61 Ursæ maj.	11 34 27·91	+3·176	+34 54 27·3	20·33	1403	...	
χ Ursæ maj.	11 39 26·62	+3·196	+48 28 19·8	19·98	...	163	
β Leonis	11 42 40·97	+3·065	+15 16 14·5	20·10	1411	164	
B.A.C. 4005	11 44 30·36	+3·093	+12 58 22·9	20·01	1414	...	Greenwich, 1874, &c.
1 Comæ	11 55 20·04	+3·080	+22 47 26·2	20·07	1437	...	
o Virginis	11 58 50·50	+3·059	+9 25 37·9	20·02	1442	167	
Groombridge 1852	11 58 52·08	+3·147	+77 36 16·2	20·17	...	440	
ε Corvi	12 3 41·91	+3·076	−21 55 28·0	20·04	1447	...	
Draconis 4 H.	12 6 19·20	+2·903	+78 18 39·3	20·03	1453	168	
δ Ursæ maj.	12 9 13·96	+3·005	+57 43 37·0	20·06	...	169	
2 Canum Ven.	12 9 51·49	+3·024	+41 21 21·8	20·07	...	441	Recent Greenwich obs.
η Virginis	12 13 30·64	+3·068	+0 1 40·7	20·04	1464	170	
B.A.C. 4165	12 14 18·44	...	+88 23 33·7	...	1469	...	= Brad. 1672; Greenwich
6 Canum Ven.	12 19 41·28	+2·970	+39 42 43·4	20·03	...	442	
20 Comæ	12 23 26·45	+3·026	+21 35 18·6	19·97	1483	443	
8 = β Canum Ven.	12 27 48·18	+2·862	+42 2 13·1	19·61	1492	445	
24 Comæ seq.	12 28 51·56	+3·016	+19 3 55·1	19·87	1496	446	
26 Comæ	12 32 54·13	+2·994	+21 45 1·2	19·84	1505	...	
δ Virginis	12 49 18·47	+3·020	+4 4 37·3	19·66	1531	174	
α Canum Ven.	12 50 10·70	+2·816	+38 59 37·6	19·53	1532	175	
37 Comæ	12 54 17·45	+2·880	+31 27 35·8	19·50	1538	...	
ε Virginis	12 55 57·26	+2·987	+11 37 53·1	19·43	1541	176	
θ Virginis	13 3 28·74	+3·100	−4 52 16·8	19·33	1549	449	
α Virginis	13 18 36·55	+3·151	−10 30 29·7	18·93	1571	...	
ζ Virginis	13 28 19·49	+3·053	+0 2 38·0	18·53	1589	179	
Canum Ven. 17 H.	13 29 12·80	+2·683	+37 49 23·5	18·56	..	454	
τ Boötis	13 41 19·36	+2·854	+18 4 50·0	18·08	1601	180	
η Ursæ maj.	13 42 36·84	+2·373	+49 56 15·7	18·10	1604	181	
e Boötis	13 43 48·23	+2·843	+21 53 8·7	17·87	1607	...	
η Boötis	13 48 43·98	+2·857	+19 1 30·3	18·20	1615	182	
τ Virginis	13 55 17·16	+3·049	+2 9 0·1	17·63	1623	183	

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	h.	m.	s.	s.	°	′	″	″			
d Boötis	14	4	41·84	+2·739	+25	41	4·5	−17·21	1637	458	
κ Virginis	14	6	13·79	+3·193	− 9	41	27·1	16·95	1641	185	
4 Ursæ min.	14	9	22·02	−0·336	+78	8	4·9	16·93	...	459	
α Boötis	14	9	57·62	+2·734	+19	50	3·1	18·88	1647	187	
A Boötis	14	12	42·64	+2·532	+36	5	13·0	16·79	1651	...	
ϕ Virginis	14	21	45·86	+3·089	− 1	40	0·2	16·36	...	191	
ρ Boötis	14	26	26·60	+2·588	+30	55	16·4	15·94	1665	192	
z Octantis	14	29	12·58	...	−87	37	56·9	...	...	...	Stone (8 s. polar stars)*
33 Boötis	14	34	11·08	+2·233	+44	56	41·8	15·70	...	461	
π Boötis, pr.	14	34	51·11	+2·818	+16	57	18·4	15·65	...	194	
ϵ^2 Boötis	14	39	31·69	+2·619	+27	36	7·9	15·38	1679	...	
109 Virginis	14	39	55·85	+3·029	+ 2	25	14·7	15·39	...	197	
α^2 Libræ	14	43	57·94	+3·309	−15	31	15·7	15·20	1683	...	
β Ursæ min.	14	51	5·35	−0·245	+74	39	57·9	14·76	1695	198	
β Boötis	14	57	14·28	+2·261	+40	53	3·7	14·41	1702	199	
ψ Boötis	14	59	5·38	+2·570	+27	26	9·3	14·25	1704	465	
β Libræ	15	10	16·95	+3·221	− 8	55	13·1	13·55	1719	200	
δ Boötis	15	10	27·88	+2·421	+33	46	56·1	13·62	1720	201	
11 Ursæ min.	15	17	12·63	−0·066	+72	16	39·0	13·05	1736	...	9-year cat.
Groombridge 2283	15	18	16·35	...	+87	42	35·2	...	1743	...	2nd 7-year cat.
μ Boötis	15	19	46·12	+2·266	+37	48	59·3	12·82	1737	202	
γ Ursæ min.	15	20	56·76	−0·133	+72	16	43·6	12·81	1740	203	
β Coronæ	15	22	40·60	+2·476	+29	32	15·2	12·63	...	205	
ν Boötis, 1st star	15	26	26·39	+2·153	+41	15	37·0	12·44	...	206	
α Coronæ	15	29	23·77	+2·539	+27	8	12·2	12·31	1752	209	
α Serpentis	15	38	6·72	+2·951	+ 6	49	13·0	11·58	1764	212	
δ Coronæ	15	44	21·14	+2·508	+26	27	7·9	11·25	1775	...	
ζ Ursæ min.	15	48	33·80	−2·297	+78	10	40·7	10·90	1790	217	
γ Serpentis	15	50	40·81	+2·766	+16	4	15·4	12·01	1792	218	Auwers
λ Coronæ	15	51	14·82	+2·182	+38	18	32·2	10·59	1796	...	
κ Herculis	16	2	26·03	+2·702	+17	22	53·0	9·85	1823	...	
τ Coronæ	16	4	24·18	+2·195	+36	48	34·8	9·34	1828	...	
δ Ophiuchi	16	7	47·77	+3·140	− 3	22	15·3	9·58	1837	222	
υ Coronæ	16	11	44·43	+2·404	+29	27	37·6	9·18	1847	...	
γ Herculis	16	16	24·39	+2·644	+19	26	52·5	8·71	1855	225	
α Scorpii	16	21	44·75	+3·668	−26	9	9·2	8·38	1864	...	
σ Herculis	16	30	4·46	+1·933	+42	41	45·2	7·61	...	230	

* 'Places of Eight Close Southern Polar Stars.' Cape of Good Hope, 1874.

MEAN RIGHT ASCENSIONS OF THE STARS USED IN ALL THE LONGITUDE OPERATIONS EXCEPTING THE CHRONOMETRIC CONNECTION WITH RODRIGUEZ (*continued*).

Star's name	Right Ascension, 1875·0			Annual variation in R.A.	Declination, 1875·0			Annual variation in declination	Number in 2nd 7-year cat. 1864	Number in Auwers' cat.	Other authorities, &c.
	h.	m.	s.	s.	°	′	″	″			
24 Scorpii	16	34	20·73	+3·461	−17	29	53·6	−7·32	1886	...	
Groombridge 2373	16	36	2·87	−2·670	+77	41	37·9	6·91	...	476	
ζ Herculis	16	36	34·54	+2·264	+31	49	49·5	6·73	1891	231	
κ Ophiuchi	16	51	45·10	+2·835	+ 9	34	15·2	5·88	1913	233	
ε Herculis	16	55	30·49	+2·294	+31	6	41·8	5·54	1918	234	
ε Ursæ min.	16	58	50·80	−6·379	+82	14	22·3	5·31	1924	235	
a^1 Herculis	17	8	56·91	+2·734	+14	32	3·8	4·38	1936	237	
α Ophiuchi	17	29	7·94	+2·782	+12	39	9·8	2·90	1957	241	
67 Ophiuchi	17	54	23·16	+3·003	+ 2	56	21·1	−0·53	1986	253	
72 Ophiuchi	18	1	25·43	+2·843	+ 9	32	50·9	+0·19	2000	254	
δ Ursæ min.	18	12	39·55	...	+86	36	27·7	...	2030	256	
η Serpentis	18	14	50·52	+3·100	− 2	55	46·1	0·61	2025	257	
σ Octantis	18	15	27·59	...	−89	16	38·6	...	...	...	Stone (8 s. polar stars)
α Lyræ	18	32	42·40	+2·031	+38	40	6·3	3·14	2050	260	
β^1 Lyræ	18	45	27·89	+2·211	+33	13	7·3	3·94	2071	264	
ε Aquilæ	18	53	56·96	+2·721	+14	53	59·5	4·59	2094	267	
Groombridge 2900	19	29	12·96	−3·504	+79	21	1·6	7·58	...	497	
λ Ursæ min.	19	49	16·75	...	+88	55	51·5	...	2237	284	Greenwh. clock list, 1875
a^2 Capricorni	20	11	7·10	+3·328	−12	55	50·5	10·82	2270	...	
76 Draconis	20	51	30·66	−3·954	+82	3	59·4	13·65	2367	508	
61^1 Cygni	21	1	17·67	+2·681	+38	8	8·3	17·48	2393	302	
B Octantis	21	3	50·24	...	−89	25	27·8	...	...	...	Stone (8 s. polar stars)
ζ Cygni	21	7	37·07	+2·552	+29	42	54·9	14·61	2404	303	
β Aquarii	21	24	58·66	+3·163	− 6	7	12·6	15·62	2439	307	
ξ Aquarii	21	31	5·78	+3·196	− 8	24	49·8	15·93	2452	...	
ε Pegasi	21	38	2·81	+2·946	+ 9	18	10·3	16·34	2472	309	
16 Pegasi	21	47	22·53	+2·726	+25	20	15·4	16·79	2495	518	
α Gruis	22	0	20·77	+3·812	−47	33	54·0	17·20	...	...	Cape observations
24 Cephei	22	7	23·97	+1·168	+71	43	31·8	17·67	2549	521	
θ Aquarii	22	10	14·22	+3·153	− 8	24	18·4	17·78	2551	522	
α Piscis aust.	22	50	44·39	+3·327	−30	17	4·0	18·97	2621	...	
α Pegasi	22	58	32·13	+2·986	+14	31	59·6	19·33	2634	329	
τ Octantis	23	8	17·49	...	−88	10	2·7	...	...	...	Stone (8 s. polar stars)
ψ^1 Aquarii	23	9	20·54	+3·145	− 9	46	6·2	19·55	2658	...	
κ Piscium	23	20	31·48	+3·076	+ 0	34	16·9	19·64	2683	534	
ι Piscium	23	33	31·32	+3·086	+ 4	56	55·7	19·47	2708	333	
δ Sculptoris	23	42	24·76	+3·138	−28	49	16·8	19·90	2725	...	
ω Piscium	23	52	53·56	+3·076	+ 6	10	16·2	19·94	2750	336	

The right ascensions for 1874·0 of the stars used in the chronometric runs between the British Transit of Venus station at Rodriguez and the observatory at Pamplemousses, as well as the observations on December 25–27, 1874, for finding the personal equation between Lieutenant Neate, Mr. Burton, and Mr. Gill, were taken, as far as possible, from the list of Clock Stars used at Greenwich. To supplement these a number of stars were chiefly selected from the 'Greenwich New Seven-year Catalogue . . . for 1864,' and brought up to 1874·0 by the precessions and proper motions of that catalogue, which at that time formed the basis of the Greenwich list. The southern polar stars were again adopted unaltered from the two Cape lists of stars near the south pole. The right ascensions of α Canis maj. and α Canis min. were derived as before from Professor Newcomb's memoir already quoted; their places include Auwers' periodic corrections. The following table gives the adopted mean right ascension for 1874·0, together with corrections to the apparent places of the 'Nautical Almanac.' Every star not taken from the Greenwich clock list is marked with an asterisk :—

B. Mean Right Ascensions of the Stars used in the Longitude Operations with Rodriguez and the Observations connected therewith.

Star's name	Assumed mean R.A. 1874·0	Correction to 'Nautical Almanac'	Star's name	Assumed mean R.A. 1874·0	Correction to 'Nautical Almanac'
	h. m. s.	s.		h. m. s.	s.
α Andromedæ	0 1 52·62	−0·02	*10 Tauri	3 30 26·63	...
γ Pegasi	0 6 44·91	−0·02	η Tauri	3 39 59·81	0·00
*o Octantis	0 12 58·94	...	γ^1 Eridani	3 52 9·02	+0·01
*47 Piscium	0 21 28·96	...	A^1 Tauri	3 57 14·88	...
12 Ceti	0 23 36·44	−0·03	ω^1 Tauri	4 1 49·64	...
*26 Ceti	0 57 19·90	...	o^1 Eridani	4 5 42·90	+0·03
β Andromedæ	1 2 40·92	...	*Lacaille 1592	4 6 9·04	...
*f Piscium	1 11 17·98	...	*o^2 Eridani	4 9 28·42	...
θ Ceti	1 17 43·48	+0·01	*54 Persei	4 12 13·94	...
η Piscium	1 24 44·56	+0·01	ϵ Tauri	4 21 15·60	0·00
*α Eridani	1 33 1·03	+0·07	*θ^1 Tauri	4 21 22·67	...
β Arietis	1 47 40·88	+0·02	α Tauri	4 28 41·50	−0·02
α Arietis	2 0 4·38	−0·01	τ Tauri	4 34 41·00	...
*Lacaille 764	2 5 31·55	...	μ Eridani	4 39 12·16	...
67 Ceti	2 10 41·90	−0·01	*i Tauri	4 44 0·30	...
*69 Ceti	2 15 29·33	...	ι Aurigæ	4 48 47·39	+0·01
ξ^2 Ceti	2 21 27·66	+0·01	*64 Eridani	4 54 4·41	...
*Lacaille 1029	2 39 44·18	...	ϵ Leporis	5 0 7·64	+0·04
σ Arietis	2 44 32·24	...	β Orionis	5 8 28·95	0·00
*6 Eridani	2 52 29·51	...	β Tauri	5 18 19·66	−0·05
α Ceti	2 55 41·63	+0·01	δ Orionis	5 25 34·17	−0·02
δ Arietis	3 4 25·59	0·00	ϵ Orionis	5 29 49·17	+0·01
*α Persei	3 15 20·08	−0·08	α Columbæ	5 35 5·29	0·00
o Tauri	3 18 2·08	...	α Orionis	5 48 21·02	−0·01
ϵ Eridani	3 26 59·65	...	*Lacaille 2512	6 12 58·34	...

MEAN RIGHT ASCENSIONS OF THE STARS USED IN THE LONGITUDE OPERATIONS WITH RODRIGUEZ AND THE OBSERVATIONS CONNECTED THEREWITH (*continued*).

Star's name	Assumed mean R.A. 1874·0			Correction to 'Nautical Almanac'	Star's name	Assumed mean R.A. 1874·0			Correction to 'Nautical Almanac'
	h.	m.	s.	s.		h.	m.	s.	s.
γ Geminorum	6	30	25·90	−0·03	a^2 Capricorni	20	11	3·70	+0·02
*α Canis maj.	6	39	35·63	−0·07	β Capricorni	20	13	55·78	...
ε Canis maj.	6	53	40·42	−0·03	*α Pavonis	20	15	39·94	−0·43
δ Geminorum	7	12	35·81	−0·03	ρ Capricorni	20	21	40·24	+0·02
a^2 Geminorum	7	26	33·48	−0·03	ε Delphini	20	27	11·55	...
*α Canis min.	7	32	42·25	−0·10	α Delphini	20	33	47·12	...
6 Cancri	7	55	46·61	+0·03	*α Cygni	20	37	8·18	0·00
15 Argûs	8	2	10·65	−0·04	*λ Cygni	20	42	30·05	...
*A Octantis	8	11	15·38	...	32 Vulpeculæ	20	49	11·39	−0·02
η Cancri	8	25	25·20	+0·02	*B Octantis	21	2	14·14	...
*z Octantis	14	28	50·09	...	*ν Aquarii	21	2	43·70	...
α Scorpii	16	21	41·03	−0·01	ι Capricorni	21	15	13·68	...
a^1 Herculis	17	8	54·13	−0·02	β Aquarii	21	24	55·43	+0·02
*β Draconis	17	27	35·14	−0·09	ξ Aquarii	21	31	2·52	...
μ Herculis	17	41	31·67	0·00	ε Pegasi	21	37	59·84	−0·03
89 Herculis	17	50	20·21	...	δ Capricorni	21	40	5·01	...
*γ Draconis	17	53	40·87	+0·05	16 Pegasi	21	47	19·77	−0·03
μ^1 Sagittarii	18	6	13·63	+0·02	α Aquarii	21	59	18·63	0·00
*σ Octantis	18	13	38·63	−5·42	*υ or C Octantis	22	6	50·20	...
η Serpentis	18	14	47·38	...	θ Aquarii	22	10	10·97	0·00
α Lyræ	18	32	40·32	−0·02	γ Aquarii	22	15	8·82	...
β^1 Lyræ	18	45	25·66	−0·01	η Aquarii	22	18	52·82	+0·02
ε Aquilæ	18	53	54·17	...	ζ Pegasi	22	35	10·63	+0·01
ζ Aquilæ	18	59	37·06	+0·01	μ Pegasi	22	43	55·36	...
*π Sagittarii	19	2	16·15	...	λ Aquarii	22	46	2·32	...
ψ Sagittarii	19	7	48·72	...	α Piscis aust.	22	50	40·99	+0·01
ω Aquilæ	19	11	54·08	0·00	α Pegasi	22	58	29·09	0·00
δ Aquilæ	19	19	8·65	+0·01	*τ Octantis	23	8	4·99	...
α Vulpeculæ	19	23	27·74	...	γ Piscium	23	10	37·94	−0·02
h^2 Sagittarii	19	29	2·27	+0·07	κ Piscium	23	20	28·35	−0·01
e^1 Sagittarii	19	33	30·19	...	ι Piscium	23	33	28·16	0·00
γ Aquilæ	19	40	16·12	−0·04	δ Sculptoris	23	42	21·55	0·00
α Aquilæ	19	44	38·09	−0·03	ω Piscium	23	52	50·47	0·00
β Aquilæ	19	49	7·40	−0·01	2 Ceti	23	57	16·99	...
θ Aquilæ	20	4	48·14	...					

In the experiments made at Dun Echt in the early part of 1876 for finding Mr. Gill's personal equation when observing with the Simms' altazimuth and with Dr. Löw's transit instrument, the

apparent places of the stars were derived from the 'Mittlere Oerter für 1876·0 von 539 Sternen, &c,' Berlin, 1876, by the application of the corrections in the thirteenth volume of the 'Vierteljahrsschrift der astronomischen Gesellschaft,' p. 205 *et seq.* The places then become almost exactly identical with those of Auwers' fundamental catalogue. An exception was made in the case of the Pole Star, which was taken in accordance with Greenwich observations and the 'Nautical Almanac.' In the adjoining table are the adopted mean right ascensions, and the corrections of the Berlin ephemerides for each star except Polaris.

C MEAN RIGHT ASCENSIONS OF THE STARS OBSERVED IN THE EXPERIMENTS AT DUN ECHT.

Star's name	Mean R.A. 1876·0	Correction to ephemeris	Star's name	Mean R.A. 1876·0	Correction to ephemeris
	h. m. s.	s.		h. m. s.	s.
α Ursæ min.	1 13 19·88*	[N.A. −0·05]	36 Lyncis	9 5 41·31	−0·02
β Aurigæ	5 50 26·01	−0·05	38 Lyncis	9 11 7·39	+0·11
μ Geminorum	6 15 27·52	−0·02	40 Lyncis	9 13 29·79	+0·07
8 Lyncis	6 26 21·22	+0·06	Draconis 1 H.	9 19 14·92	+0·41
γ Geminorum	6 30 32·91	+0·02	10 Leonis min.	9 26 37·34	−0·12
Cephei 51 H.	6 41 45·60	−0·28	ε Leonis	9 38 48·61	+0·03
ζ Geminorum	6 56 45·23	+0·01	υ Ursæ maj.	9 42 9·46	+0·04
λ Geminorum	7 10 57·96	−0·01	μ Leonis	9 45 42·51	+0·08
δ Geminorum	7 12 42·96	−0·02	η Leonis	10 0 34·28	+0·09
ι Geminorum	7 18 1·42	−0·03	α Leonis	10 1 46·00	+0·01
ρ Geminorum	7 21 8·02	+0·04	λ Ursæ maj.	10 9 36·72	+0·08
α Canis min.	7 32 48·46	−0·08	μ Ursæ maj.	10 14 56·16	+0·04
κ Geminorum	7 36 57·59	−0·14	31 Leonis min.	10 20 42·51	+0·02
β Geminorum	7 37 43·57	+0·01	Draconis 9 H.	10 24 30·09	−0·15
26 Lyncis	7 45 40·64	+0·20	ρ Leonis	10 26 16·86	+0·09
6 Cancri	7 55 54·01	0·00	37 Ursæ maj.	10 27 9·67	0·00
o Ursæ maj.	8 19 56·83	+0·02	41 Leonis min.	10 36 40·29	−0·01
η Cancri	8 25 32·18	0·00	42 Leonis min.	10 38 57·97	−0·03
δ Cancri	8 37 38·18	−0·01	β Ursæ maj.	10 54 20·84	+0·02
ι Cancri	8 39 11·44	+0·04	ψ Ursæ maj.	11 2 41·17	+0·09
ι Ursæ maj.	8 50 42·61	+0·05	δ Leonis	11 7 30·71	+0·04
10 Ursæ maj.	8 52 35·08	+0·10	58 Ursæ maj.	11 23 48·20	+0·01
κ Ursæ maj.	8 55 9·14	+0·17	β Leonis	11 42 44·02	+0·01

* This is the Greenwich Clock List place of α Ursæ min.

II.

MEAN PLACES FOR 1874·0 OF THE STARS USED IN FINDING THE LATITUDE BY CIRCUM-MERIDIAN ALTITUDES.

Star's Name	Right Ascension 1874·0			Ann. var. in R.A.	Declination 1874·0			Ann. var. in Dec.	Annual prop. mot.	Authorities
	h.	m.	s.	s.	°	′	″	″	″	
β Hydri	0	19	5·83	+ 3·27	−77	57	50·40	+20·29	+0·31	Boss
α Ursæ min.	1	12	39·33	+20·87	+88	38	14·81	+19·05	0·00	Boss
σ Arietis	2	44	32·28	+ 3·30	+14	33	41·39	+15·06	−0·05	Greenwich 9-year cat.
Lacaille 1092	3	16	33·65	+ 0·65	−67	23	8·36	+12·97	−0·15	Cape cat. of 1159 stars
o Tauri	3	18	2·08	+ 3·22	+ 8	35	1·75	+12·93	−0·09	Boss
η Tauri	3	39	59·85	+ 3·55	+23	42	49·13	+11·44	−0·06	Boss
27 Tauri	3	41	40·37	+ 3·55	+23	39	58·51	+11·32	−0·07	Greenwich 9-year cat.
37 Tauri	3	57	14·87	+ 3·53	+21	44	8·30	+10·15	−0·09	Greenwich 9-year cat.
α Reticuli	4	12	48·39	+ 0·76	−62	47	21·98	+ 9·12	+0·07	Cape and Melbourne
α Tauri	4	28	41·56	+ 3·44	+16	15	14·20	+ 7·58	−0·19	Boss
τ Tauri	4	34	41·04	+ 3·59	+22	42	47·03	+ 7·27	−0·02	Greenwich 9-year cat.
λ Pictoris	4	39	32·89	+ 1·54	−50	43	8·46	+ 6·92	+0·02	Cape cat. of 1159 stars
α Columbæ	5	35	5·23	+ 2·17	−34	8	33·35	+ 2·13	−0·05	Boss
β Cancri	8	9	40·84	+ 3·26	+ 9	34	19·89	−10·81	−0·05	Boss
o Ursæ maj.	8	19	46·86	+ 5·04	+61	8	12·42	−11·62	−0·12	Boss
ι Ursæ maj.	8	50	34·26	+ 4·14	+48	32	4·71	−13·84	−0·25	Boss
θ Hydræ	9	7	48·56	+ 3·13	+ 2	50	40·04	−14·95	−0·32	Greenwich, 1st 7-year cat.
κ Ophiuchi	16	51	42·26	+ 2·84	+ 9	34	21·34	− 5·89	−0·01	Boss
β Draconis	17	27	35·15	+ 1·35	+52	23	43·40	− 2·83	0·00	Boss
α Ophiuchi	17	29	5·22	+ 2·78	+12	39	12·37	− 2·93	−0·24	Boss
72 Ophiuchi	18	1	22·56	+ 2·84	+ 9	32	51·22	+ 0·21	+0·06	Greenwich 9-year cat.
α Lyræ	18	32	40·37	+ 2·03	+38	40	3·04	+ 3·12	+0·27	Boss
α Pavonis	20	15	39·91	+ 4·79	−57	8	10·24	+11·11	−0·09	Boss
α Cygni	20	37	8·26	+ 2·04	+44	49	51·28	+12·69	−0·01	Boss
61¹ Cygni	21	1	15·11	+ 2·69	+38	7	50·98	+17·49	+3·23	Boss
α Gruis	22	0	16·89	+ 3·81	−47	34	11·38	+17·21	−0·03	Boss
ζ Pegasi	22	35	10·61	+ 2·99	+10	10	27·08	+18·69	−0·01	Boss
γ Piscium	23	10	37·98	+ 3·11	+ 2	35	38·98	+19·58	−0·01	Greenwich 9-year cat.
ι Piscium	23	33	28·32	+ 3·08	+ 4	56	36·71	+19·48	−0·44	Boss

Spottiswoode & Co., Printers, New-street Square, London.